# Resource Recovery



AJAX STEAM PLANT VIABILITY STUDY

PREPARED BY

ACRES SHAWINIGAN LIMITED
TORONTO, ONTARIO

FOR

THE MINISTRY OF THE ENVIRONMENT
AND
THE MINISTRY OF ENERGY

DECEMBER, 1976



Ministry
of the
Environment

Ontario

Ajax steam plant viability study /

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Ajax Steam Plant is the seventh in the series of Energy Conservation Reports being produced under the sponsorship of the Ontario Energy Management Program.

The following publications in this series are available from the Ontario Government Bookstore (880 Bay Street, Toronto).

Wind Power Report
District Heating Study
Energy Analysis of Resource Recovery Options
Solid Waste for Industrial Fuel
Waste Oil Recycling Study
Methanol in Ontario

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SUMMARY

## SUMMARY

Due to economic and technical factors beyond its control, continued support of the Industrial Steam Heating System in Ajax by Alliance Building Corporation is in considerable doubt and will remain so unless its performance can be improved or a much cheaper fuel source located. Otherwise, Alliance will shut the plant down when its contract with the Town of Ajax expires in 1981.

This study evaluates modification of the plant to improve its efficiency and a change from private to public ownership to improve its financial viability, both in an attempt to reduce steam-selling prices to a point competitive with natural gas which is the far cheaper alternative currently. Consideration is also given to heat recovery from refuse, normally disposed to landfill, by a public utility with temporary support for the steam plant until the incinerators can be put in operation.

It is concluded that all measures to improve the efficiency of the existing steam plant or its financial management would not achieve a reduction in steam cost sufficient to make it competitive with gas. The only potentially feasible proposal is the use of refuse for steam generation by a public utility, with the existing steam plant maintained meanwhile at present loads by government subsidy. However, further study of this alternative itself would only be merited if the principle and extent of the subsidy can be agreed among the various levels of government concerned.

Should heat refuse recovery by a public utility not be proven feasible, then shut down of the steam plant by 1981 seems inevitable. The impact of this will fall most heavily on the existing steam-using community which will be required to invest \$2,000,000 - 3,000,000 in new gas-fired boilers. There will be an increase in natural gas consumption of over 400 million cubic feet and a decrease in oil consumption of 97,000 barrels. Though low level nitrous oxide emission will increase, sulphur discharge to atmosphere will reduce by 380 tons per year.

The main factors for the uneconomic viability of the system, as compared to those of a typical, successful, modern district heating scheme are:

- System steam conditions were designed for process, but the main load is now heating;

- Condensate is not returned;

- Low system load density;

- Piping heat losses are high owing to the use of high temperature steam and minimum insulation thickness.

# 1 - AUTHORITY AND TERMS OF REFERENCE

In response to an invitation from the Ministry of the Environment dated July 23, 1976, Acres Shawinigan Limited submitted a proposal dated August 13 covering a study of the viability of the continued operation of the Ajax Steam Plant. On September 10 the Ministry advised Acres Shawinigan of their intent to enter into an Agreement for the execution of the study. This Agreement was subsequently completed on October 8, 1976.

## 1.1 - Study Objectives

The objectives of the study as set forth by the Ministry were to identify the problems and issues affecting the long term viability of the industrial steam plant and provide an analysis and recommendation for steps which can be taken to maintain its operation or recommend alternate means of providing energy to existing steam users.

## 1.2 - Study Outline

The scope of the Consultant's work was defined as the following:

1.2.1 - An inventory of plant equipment with comments regarding expected useful life of existing equipment.

1.2.2 - A description of the steam distribution network.

1.2.3 - A listing of the major users of steam under the categories of process steam users and comfort heating steam users.

1.2.4 - A statement of the problems which have been identified, including environmental problems.

1.2.5 - An examination of the potential for using alternate fuels such as municipal refuse as a complete or partial replacement for existing fuels.

1.2.6 - A financial analysis of the existing situation and any changes necessary to make the operation of the industrial steam plant viable.

1.2.7 - An analysis of the implications to all levels of government, should the industrial steam plant cease operations.

1.2.8 - Recommendations on steps necessary to provide for continued operation of the industrial steam plant or alternate means of providing energy to existing customers should continued operation prove to be unacceptable.

## 2 - INTRODUCTION

When the Ajax industrial and commercial section was established during the second World War, a central steam supply system was included as an added inducement to prospective occupants. In 1972, Alliance Building Corporation acquired substantial holdings in the area, including the steam plant which it continued to operate as Industrial Steam Limited under a contract with the Town of Ajax.

Over the past few years, the annual amount of steam sold to customers has been declining and is expected to continue to decline in the future. This has been in part due to economic conditions outside the control of Alliance. However, the principal problem is now the increasing cost of fuel which, combined with the inherent inefficiency of a steam plant designed over 30 years ago, has trebled the steam selling price in recent years. As a result, natural gas has become an increasingly attractive alternative to purchased steam, so much so that two of Alliance's major process steam customers have found it economic to install their own gas-fired boiler plants and at least two more are actively considering similar action.

The steam selling price is subject to the approval of the Ontario Energy Board based on an allowed utility rate of return on a deemed rate base. This return, coupled with the diminishing demand for steam and a potential need for more capital investment to increase the height of the chimney, makes continued operation of the steam plant unacceptable in terms of Alliance's financial objectives. It is evident that they do not intend to renew their contract with Ajax when it expires in 1980. Unless other events intervene, they will shut the system down.

The impact of such a move is of considerable concern to the Town of Ajax and to Provincial authorities whose joint concerns extend to energy conservation, the environment, trade and industry. No less concerned are the present customers who would be forced to seek alternate heat sources involving new capital investment and new operating costs on their part.

It is the prospect of steam plant shut down that has caused the Ontario Ministry of the Environment to commission this study. In the following pages the problems surrounding the operation of the steam supply system are discussed and possible solutions investigated.

The study also evaluates the impact of shutting down the system upon the steam users and the various levels of government if continued operation is not proven viable.

# 3 - STEAM DEMAND AND FUEL COSTS

Before proceeding with an assessment of the steam supply system performance and evaluation of measures to improve this performance, the effects of steam demand and fuel price on the cost of steam production are discussed.

## 3.1 - Steam Supply Area

The 54 steam customers supplied from the central boiler plant are listed in Table 3.1. Their locations relative to the central plant are shown on Figure 3.1. The distribution of the major steam loads in the supply area is shown on Figure 3.2.

## 3.2 - Steam Demand

The economic performance of a steam supply system is dependent to a large degree on the system steam demand and its annual characteristics as they relate to the installed steam generating capacity. Load density is also an important economic factor.

### 3.2.1 - Annual Steam Demand

The annual demand for steam in Ajax reached a peak in 1969 when 369 million pounds were sold. Since then, the demand has varied between 300 and 350 million pounds a year, 331 million being sold in 1975. The total sale of steam in 1976 will probably be in the order of 300 million pounds and in 1977, 285 million pounds.

For the most part, the general decline in the demand for steam between 1969 and 1975 has been due to factors outside the control of Alliance. Some losses were due to economic problems of its customers and some because of the transient nature of certain commercial users.

However, the decline in steam use in 1976 and 1977 is principally because two of Alliance's major process steam customers, first Sandara Coffee and then Ajax Textile, have installed their own gas-fired boilers, reducing their annual steam requirement by some 47 million pounds, about 14 per cent of the amount sold in 1975. It is understood that other steam customers are considering defection so that

the 1977 steam sale may be even lower than 285 million pounds.

Steam demand is a significant factor in the determination of the steam selling price. If the steam plant could be operated at full capacity throughout the year, it would generate about 1,400 million pounds of steam. In 1975 it generated only 500 million pounds, 35 per cent of its potential output. In other words, it is being operated at a capacity factor of 35 per cent.

If the steam demand falls to 285 million pounds in 1977, as predicted above, the capacity factor will be reduced to 31.5 per cent. This means that the fixed charge component of the steam cost will increase by 10 per cent in 1977.

Therefore, as the steam load declines, the capacity factor is reduced. This is reflected in the tariff of steam rates used by Alliance which is based on a cost per thousand pounds. It is evident that, since the fixed annual operating costs remain unchanged whatever the amount of steam sold, a declining steam load, and hence declining capacity factor, means that these costs have to be spread over a diminishing number of pounds of steam sold and can only be recovered by increasing the rate charged to the remaining customers. The basis of the steam tariff and its regulation by the Ontario Energy Board is discussed in more detail in Section 7.

### 3.2.2 - Steam Demand Characteristics

The variation in the Ajax maximum hourly steam demand through the year is shown on Figure No. 3.3. The highest demand occurs in winter, January or February, and the lowest in summer, July or August. The curve is typical of a load which is predominantly space heating with a small year round process load, in this case representing about 20 per cent of the maximum winter demand.

This type of load has the disadvantage that enough steam generating capacity must be installed to accommodate the winter heating load. In summer, when there is no heating load and the only demand is for process, 80 per cent of this capacity is effectively idle. Notwithstanding, the fixed annual capital charges and operating costs still remain to be paid and distributed over the number of pounds of steam actually generated.

As previously described, the recent reductions in steam demand have been primarily due to the loss of process steam users and not a reduction in the heating load. The weather conditions in any particular year will influence the heating load characteristic and hence the annual boiler capacity factor. This is evident from the fact that, in 1976, due to an abnormally cold November, the steam consumption to the beginning of December was already 16 million pounds above that at the same time in 1975. The capacity factor for 1976 will therefore be higher than predicted above. However, this will not apply necessarily to succeeding years and in overall terms, the loss of process load will reduce the attainable capacity factor, whatever the climatic conditions.

In the following sections, calculations involving future annual steam consumptions have been made assuming the base heating demand that occurred in 1975 will prevail. A change in this base load will affect the precise calculation but would not necessarily alter the concept being demonstrated.

### 3.2.3 - Load Density

An important economic criteria established for district heating systems in Europe is that the density of the heating demand in the community served should not be less than 5 Therm per hour per acre. (One Therm is 100,000 Btu per hour.) This factor relates the heat demand to the investment in the heating system necessary to serve the community and the heat losses from it. A comparable figure for Canada has yet to be developed from experience, however, it will probably be of the same order. In the case of Ajax, the average heat load is 1.6 Therms per acre, one-third of the desirable level. This explains the relatively high steam loss from the Ajax distribution system, especially in summer when the whole piping system is operating at full temperature but supplying only the low summer process load. The losses due to heat transfer from the pipe to the surrounding soil are essentially the same the year round, whatever the steam demand, and therefore the percentage loss is higher in summer than in winter.

The steam users can be divided into three major supply areas as shown in Figure No. 3.4. In the northern, older area the average load density is 3.4 Therms per hour per acre, better than for the whole system but still short of the 5.0 Therms. The south-west area density is 1.4 Therms and the south-east, comprising two schools and the hospital, is 0.35 Therms.

Limiting the steam supply to the higher density load in the northern area would reduce the proportion of steam loss from the distribution system relative to the amount of steam sold and thus reduce the fuel cost component per thousand pounds of steam. In addition, there would be a reduction in steam distribution maintenance cost though this would be small compared with the overall cost of operating the steam supply system since there would be no reduction in the required number of operating staff.

On the other hand, the annual steam consumption in 1975 would have been reduced from 331 to 218 million pounds of steam. Therefore, though there would be a reduction in the fuel component of the steam price, the component due to fixed charges from capital, maintenance and operation would increase by about 33 per cent.

A rough calculation shows that the overall steam cost would in fact be increased by about 10 per cent. There would, therefore, be no useful purpose in eliminating the low density southern supply areas in an effort to improve steam load density. The situation would be worse in 1977 when the total annual steam consumption in the northern area will be reduced from 218 million to 171 million pounds. The resulting load density will be 2.54 Therms per acre, about half the economic level.

In summary, the characteristics of the steam demand in Ajax with respect to annual load pattern and load density result in a low capacity factor and hence a less than optimum distribution of annual fixed charges. The general decline in steam demand, apart from variations in heating load due to yearly climatic conditions, can only worsen the situation in this respect.

## 3.3 - Price of Fuel

The reason that steam customers are now considering installing their own boiler plant is primarily the cost of purchased heat. Compared with using natural gas, even after having paid for a new boiler plant, the purchase of steam from Alliance at the current price is no longer an economic proposition to the larger user. Added to the problem of steam price is the knowledge that Alliance are almost certain to shut the steam plant down in 1981, if not sooner, for their own economic reasons.

Prior to 1972, the price of steam sold to the customers was higher than the direct use of natural gas or fuel oil

in individual boilers but not sufficiently so to suggest that a change from purchasing steam could be attractive. The problem began when the price of fuel oil to Alliance suddenly began to increase, from about 8 cents per gallon in 1970 to 29 cents per gallon in August of 1976.

The effect of this increased fuel cost on the overall cost of operating the steam plant can be seen in Figure No. 3.5. It can be seen that in 1970, the cost of fuel represented about 44 per cent of the total annual cost of operation. By 1975 almost 68 per cent of the annual cost was due to fuel oil, primarily because cost of fuel has risen by 260 per cent compared with the 42 per cent for all other costs.

To evaluate the effect of steam demand and fuel cost on the price of natural gas or other fuels, it is necessary to convert the individual prices to a common basis of unit cost of useful heat. By useful heat is meant the heat actually available at the point of use after all losses incurred in burning the fuel or transmitting the steam have been allowed for.

Table No. 3.2 has appeared in the reports prepared by White Mossop and Erling, Consultants in 1973 and in early 1976. It is repeated here but based on the prices prevailing in November 1976. From Table 3.2 it can be seen that even the lowest steam price of $4.60 per million Btu is $2.61 higher than interruptible natural gas. This explains why conversion to gas has become attractive and why several new buildings, including the Town of Ajax Municipal Centre, have opted for gas heat rather than for purchased steam.

Against the difference in fuel prices must be set the cost of installing a gas fired boiler so that the conversion from steam can be achieved. However, this has not been a deterrent to either Sandra Coffee or Ajax Textiles.

The large difference between the price of steam and the price of gas, and the fact that this difference seems to be continuously growing, will provide an increasing incentive to the larger steam customers to change their heat source in the near future. Smaller customers and those whose length of tenancy is unpredictable, may be less willing to make the conversion in light of the capital investment and maintenance responsibilities plus the possible need for operators and prefer to stay with the steam supply system.

It would seem that, for the present, the only event that will change the minds of steam users considering committing themselves to the use of gas is a drastic reduction in the price charged for steam by Alliance. Since the fixed costs of plant operation cannot be sensibly reduced and the cost of fuel certainly is not going to decrease,

the only way of achieving a reduction in steam cost is by increasing the efficiency of energy conversion in the steam supply system and/or altering the financial structure, including change of ownership, in such a way that taxes, cost of capital repayment and need to create profit are reduced.

In the next section, efficiency of the steam supply system in converting the fuel fired in the boilers to useful heat at the customer's plant is discussed and modifications aimed at improving this efficiency evaluated.

TABLE 3.1

## INDUSTRIAL STEAM LIMITED – SCHEDULE OF STEAM USERS

| Number (P = Process Use) | Customer | Location | Steam Sales for Year Ended Dec. 31/75 Pounds | Revenue | M. Pounds | Type of Meter | Notes |
|---|---|---|---|---|---|---|---|
| 1 (P) | Porta - Flex | 439 MacKenzie | 2,620,000 | $ 10,670.28 | $4.07 | Shunt | -- |
| 2 | Northland Rubber | 595 MacKenzie | 184,000 | 885.32 | 4.81 | Shunt | Part of Alliance billing |
| 3 | Pro - Car | 284 - 286 Fairall | 154,100 | 739.43 | 4.80 | Shunt | Went broke--was in Slough Building |
| 4 | Mark Fast | 55 Mills | 186,300 | 866.25 | 4.65 | Shunt | Part building |
| 5 (P) | One Hour Martinizing | 102 Harwood Plaza | 303,600 | 1,411.04 | 4.65 | Shunt | -- |
| 6 | Becker Milk | 136 Harwood Plaza | 56,000 | 259.21 | 4.63 | Condensate | -- |
| 7 | Smithers Canada | 376 Fairall | 679,650 | 3,078.54 | 4.53 | Shunt | -- |
| 8 | Simmans & McCullough | 120 Hunt | 472,650 | 2,139.42 | 4.53 | Shunt | -- |
| 9 | Cardinal Distributors | 230 Harwood Plaza | 521,000 | 2,328.76 | 4.47 | Condensate | -- |
| 10 | Arc Industries | 177 Dowty | 867,100 | 3,831.62 | 4.42 | Shunt | -- |
| 11 (P) | McCord & Company | 275 Dowty | 1,061,000 | 4,634.54 | 4.37 | Shunt | Now Curran & Briggs |
| 12 | S. & A.D. Autonopoulos | 73 Hunt | 613,832 | 2,667.02 | 4.34 | Shunt | -- |
| 13 | Duffbrook Management | 102 Harwood Plaza | 1,355,850 | 5,833.58 | 4.30 | Shunt | -- |
| 14 | Can Aids | 239 Fairall | 1,624,000 | 6,850.32 | 4.22 | Shunt | -- |
| 15 | Redifit Wood Specialties | 160 Dowty | 2,402,350 | 10,108.91 | 4.21 | Shunt | -- |
| 16 (P) | Morton Williams | 430 Finley | 2,911,800 | 12,255.69 | 4.21 | Shunt | -- |
| 17 | Tarkien | 302 - 334 Fairall | 1,759,600 | 7,391.35 | 4.20 | Shunt | -- |
| 18 | Town of Ajax | 491 MacKenzie)<br>176 Mills ) | 2,329,500 | 9,757.14 | 4.19 | Shunt<br>Condensate | Two buildings, one bill |
| 19 | I.D.I. Electric | 33 Fuller | 2,488,600 | 10,432.25 | 4.19 | Shunt | -- |
| 20 | Sta-Rite Industries | 264 - 6 Fairall | 2,297,000 | 9,587.26 | 4.17 | Shunt | -- |
| 21 | H. G. Designs | 239 Dowty | 2,411,550 | 10,064.01 | 4.17 | Shunt | -- |
| 22 | Ontario Machine & Tool | 432 Monarch | 1,430,600 | 5,954.88 | 4.16 | Shunt | Now Perrin Filters, probable increase in demand |
| 23 | Glen S. Wooley | 228 - 30 Fairall | 1,821,600 | 7,573.10 | 4.16 | Shunt | -- |
| 24 | Goderich Tube and Steel | 89 & 115 Mills | 3,958,350 | 16,463.17 | 4.16 | Shunt | -- |
| 25 | Duffin Estates | 143 Commercial (7 Units) | 15,839,000 | 65,693.06 | 4.15 | Shunt | -- |
| 26 | ICB Warehousing | 390 Bayly | 2,133,230 | 8,816.19 | 4.13 | Bailey Orifice | -- |
| 27 | Stark Instrument | 180 Station | 2,383,750 | 9,833.06 | 4.13 | Shunt | Now occupy Duffin unit at 137 Mills |
| 28 | Sklar Furniture | 234 Clements | 2,718,000 | 11,159.18 | 4.11 | Shunt | Now gone |
| 29 | Bayly Engineering | 131, 167 & 241 Hunt | 2,754,000 | 11,321.18 | 4.11 | Shunt | -- |
| 30 | Nabob Foods | 251 Dowty | 533,600 | 2,189.81 | 4.10 | Shunt | -- |
| 31 | Slough Estates | -- | 21,545,945 | 83,022.36 | 3.85 | Shunt | 75% Fairall; 25% Frankson |
| 32 (P) | Temuss Products | 405 MacKenzie | 5,414,200 | 21,946.42 | 4.05 | Shunt | -- |
| 33 | Delany & Petit | 660 Clement | 5,554,000 | 22,423.09 | 4.04 | Shunt | -- |
| 34 | Emmet Fabricators | 81 Dowty | 3,364,900 | 13,605.27 | 4.04 | Shunt | -- |
| 35 (P) | Drew Chemical | 525 Finley | 6,756,120 | 27,198.51 | 4.03 | Shunt | -- |
| 36 | Precision Valve | 85 Fuller | 3,776,600 | 15,178.58 | 4.02 | Kent Wide Range | -- |
| 37 (P) | Cametoid | 257 Fairall | 5,411,152 | 21,680.74 | 4.01 | Bailey Orifice | -- |
| 38 (P) | DuPont Canada | 408 Fairall | 16,513,678 | 66,146.58 | 4.01 | Republic Wide Range | -- |
| 39 | Harwood Park Apartments | 60 Exeter | 6,713,290 | 26,858.55 | 4.00 | Kent Wide Range | -- |
| 40 | Perma-Glass Industries | 405 - 7 Fairall | 1,898,000 | 7,548.09 | 3.98 | Shunt | -- |
| 41 (P) | Mansonville Plastics | 70 Mills | 11,131,567 | 43,895.96 | 3.94 | Republic Wide Range | -- |
| 42 (P) | Ajax Textile | 82 Mills | 24,892,400 | 97,357.37 | 3.91 | Kent Wide Range | Have installed own boiler to meet 60 - 80% of requirements |
| 43 (P) | Keel Record | 480 Fairall | 21,237,300 | 82,074.52 | 3.86 | Kent Wide Range | -- |
| 44 | Affiliated Medical Products | 90 Commercial | 8,488,680 | 32,747.36 | 3.86 | Kent Wide Range | -- |
| 45 | Oxford Towers | 30, 42 & 50 Exeter | 21,084,610 | 81,211.26 | 3.85 | Kent Wide Range | -- |
| 46 | Ajax & Pickering Hospital | 580 Harwood | 18,234,942 | 69,958.04 | 3.84 | Republic Wide Range | -- |
| 47 (P) | Sandra Coffee | 144 Mills | 29,511,800 | 112,469.18 | 3.81 | Kent Wide Range | Now use own boilers |
| 48 (P) | Zenith Plastic & Plating | -- | 611,000 | 2,311.06 | 3.78 | Shunt | Now Can-Aids--probable lower demand |
| 49 (P) | Reed Decorative Products | 445 Finley | 23,831,400 | 89,801.31 | 3.77 | Kent Wide Range | -- |
| 50 | Adept Packaging | 334 Fairall | 650,900 | 2,336.25 | 3.59 | Shunt | Now gone |
| 51 | Chrysler Canada | 274 MacKenzie | 16,225,672 | 52,544.68 | 3.24 | Republic Wide Range | -- |
| 52 | Durham Board of Education | 80 Harwood)<br>105 Bayly ) | 17,000,771 | 36,932.54 | 2.17 | Kent Wide Range<br>Taylor Orifice | -- |
| 53 | Penkote | 358 - 60 Frankom | 595,700 | 2,785.02 | 4.68 | Shunt | -- |
| | | Year Calculations--Not Resolved | | 2,728.72 | | | |
| | | Totals | 331,316,143 | $1,279,557.00 | | | |
| | | Average Price per 1,000 lb. | | | $3.86 | | |
| 54 (P) | Melo Containers | 140 Commercial | 750,000* | | | Kent Wide Range | New Customer--*per month estimate, will probably increase! |

TABLE 3.2

COMPARISON OF ALTERNATIVE HEAT COSTS

| | Heat Content Btu | Unit Cost | Energy Cost $/MMBtu | Average Conversion Efficiency[1] % | Cost Useful Heat[1] $/MMBtu |
|---|---|---|---|---|---|
| Bunker C | 180,000/gal | 31.9¢/gal[2] | 1.77 | 80 | 2.22 |
| No. 2 Light Oil | 165,000/gal | 39.4¢/gal | 2.39 | 75 | 3.19 |
| Natural Gas - Interruptible | 1,000/cf | $1.59/mcf | 1.59 | 80 | 1.99 |
| Natrual Gas - Uninterruptible[3] | 1,000/cf | $1.82/mcf | 1.82 | 75 | 2.43 |
| Electricity[5] | 3,412/kWh | 1.9¢/kWh | 5.58 | 100 | 5.58 |
| Steam | | | | | |
| - Low Demand | 1,000/lb | $5.83/1,000 lb | 5.83 | 100 | 5.83 |
| - Medium Demand[4] | 1,000/lb | $5.22/1,000 lb | 5.22 | 100 | 5.22 |
| - Process Steam | 1,000/lb | $4.60/1,000 lb | 4.60 | 100 | 4.60 |

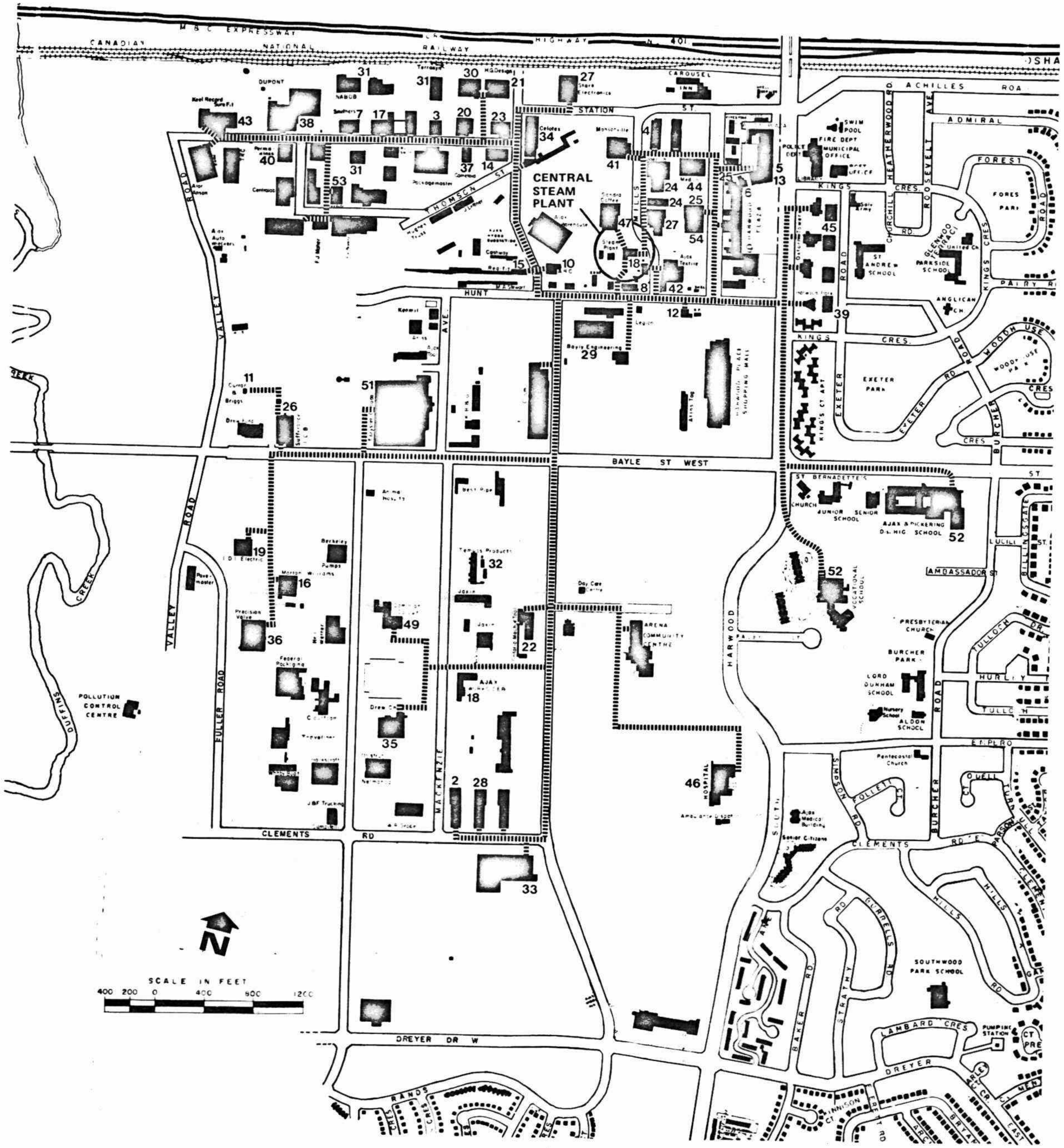
(1) At point of use, November 1976.

(2) This is the price that would be paid by users in Ajax other than Alliance who have a preferred rate of 29 cents.

(3) If available.

(4) Including 43 cents for demand on monthly load factor of 50 per cent.

(5) From Ajax Hydro Electric Commission.



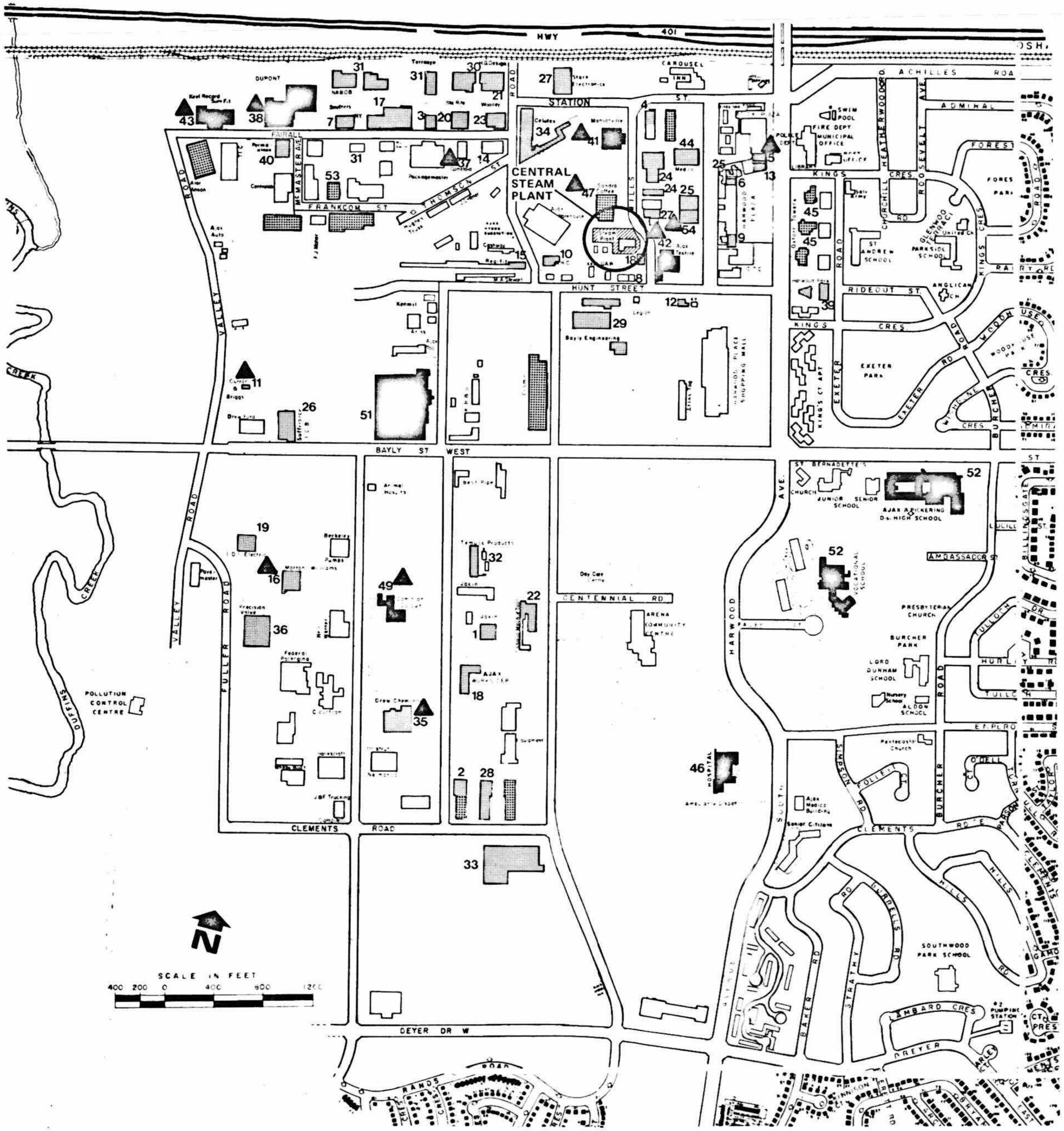

**LEGEND**

steam distribution piping

28 reference numbers relate to steam customers as listed in table 3.1

**ACRES SHAWINIGAN LIMITED**

| | |
|---|---|
| Client | ONTARIO MINISTRY OF THE ENVIRONMENT |
| Project | AJAX STEAM PLANT VIABILITY STUDY |
| Title | STEAM SUPPLY SYSTEM |
| Date | DECEMBER 1976 |
| Fig. No. | 3.1 |




## LEGEND

- load over 10 million pound/year
- load under 10 millon pound/year
- lost or reduced load
- not connected
- ▲ indicates process load

**ACRES SHAWINIGAN LIMITED**

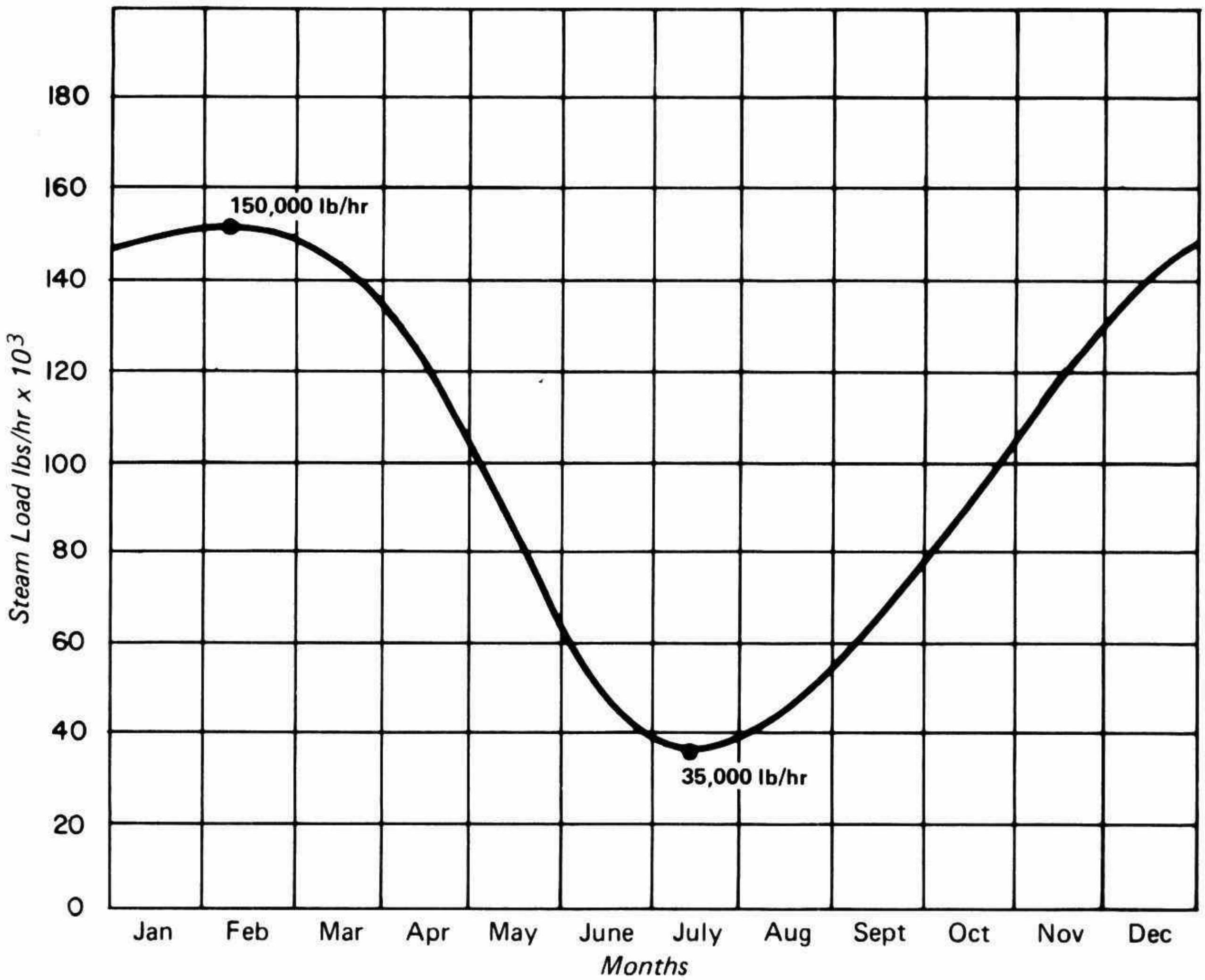
Client ONTARIO MINISTRY OF THE ENVIRONMENT

Project AJAX STEAM PLANT VIABILITY STUDY

Title

**DISTRIBUTION OF STEAM LOADS**

Date DECEMBER 1976 Fig. No. 3.2

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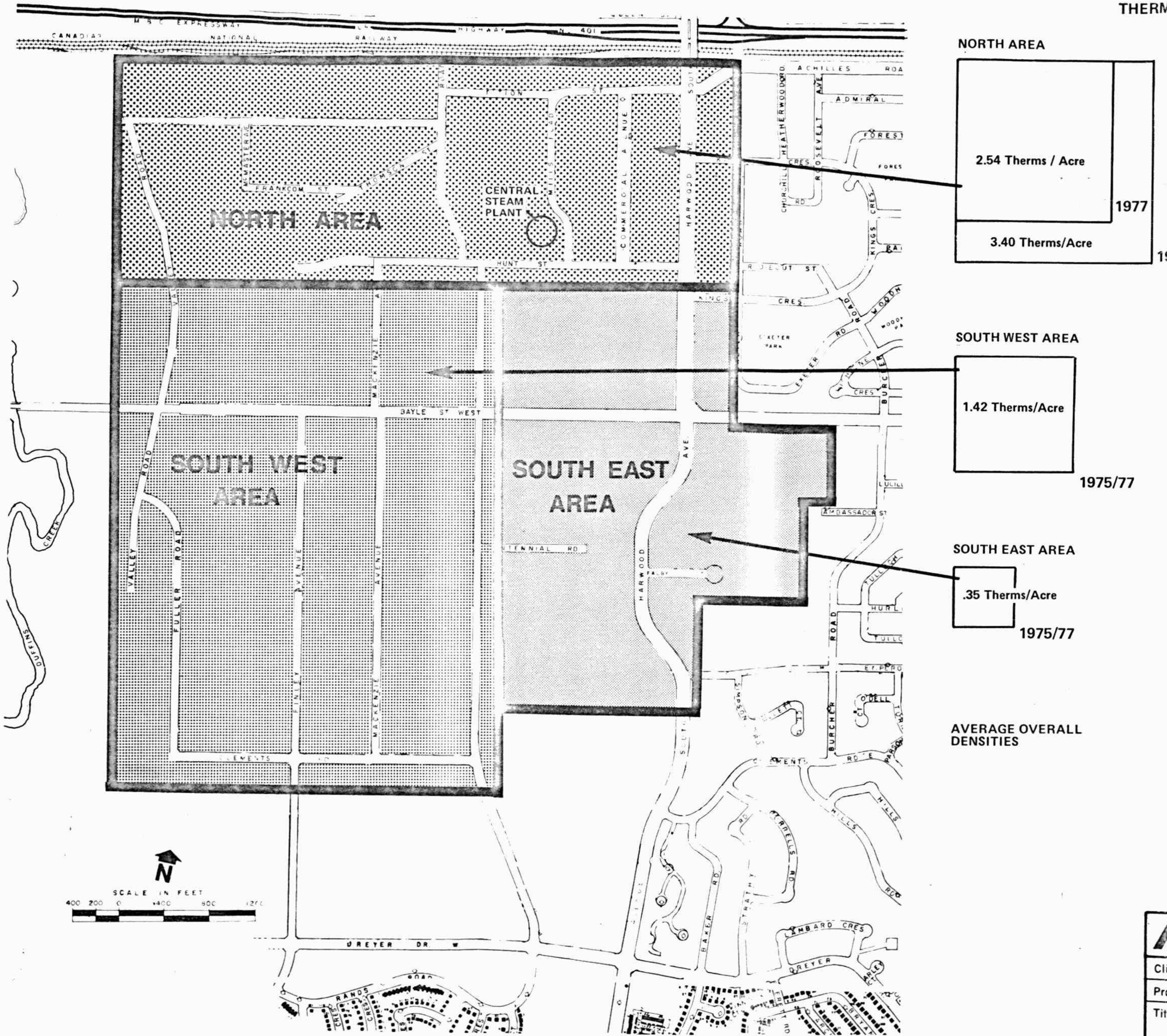
Client ONTARIO MINISTRY OF THE ENVIRONMENT

Project AJAX STEAM PLANT VIABILITY STUDY

Title **MAXIMUM HOURLY BOILER LOAD**

Date DECEMBER 1976 Fig. No. 3.3




## THERMAL LOADING DENSITIES

| | 1975 | 1977 |
|---|---|---|
| **NORTH AREA** | | |
| Percentage of System Load | 65.9 | 60.5 |
| Annual Steam Demand | $218.4 \times 10^6$ lbs. | $171.4 \times 10^6$ lbs. |
| **SOUTH WEST AREA** | | |
| Percentage of System Load | 23.2 | 26.7 |
| Annual Steam Demand | $77 \times 10^6$ lbs. | $77 \times 10^6$ lbs |
| **SOUTH EAST AREA** | | |
| Percentage of System Load | 10.9 | 12.8 |
| Annual Steam Demand | $37.3 \times 10^6$ lbs. | $37.3 \times 10^6$ lbs |
| **AVERAGE OVERALL DENSITIES** | $.16 \times 10^6$ B.T.U./ Acre | $.14 \times 10^6$ B.T.U./ Acre |

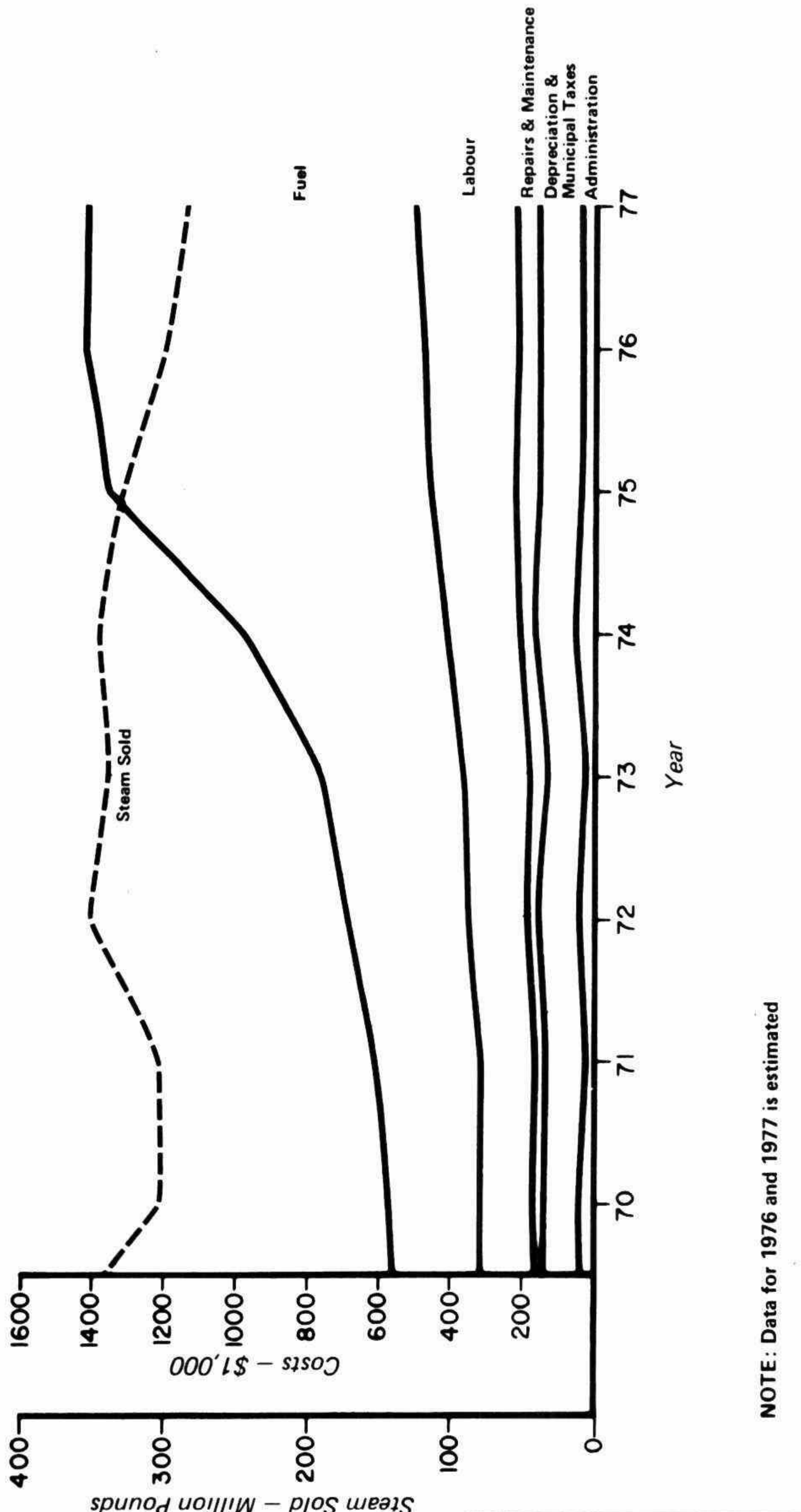
ACRES SHAWINIGAN LIMITED

Client: ONTARIO MINISTRY OF THE ENVIRONMENT

Project: AJAX STEAM PLANT VIABILITY STUDY

Title: STEAM SUPPLY AREAS AND HEAT LOAD DENSITIES

Date: DECEMBER 1976 Fig. No. 3.4




ACRES SHAWINIGAN LIMITED

Client ONTARIO MINISTRY OF THE ENVIRONMENT

Project AJAX STEAM PLANT VIABILITY STUDY

Title DISTRIBUTION OF ANNUAL COSTS

Date DECEMBER 1976 Fig. No. 3.5

# 4 - STEAM PLANT CONDITION AND PERFORMANCE

The regulations of the Ontario Energy Board as applied to Alliance in the operation of its steam supply system are not unusual in that many other utilities, be they supplying natural gas, electricity or water, are operating successfully under similar circumstances. However, in Alliance's case, the limited rate of return on capital is compounded by the problem of operating an inefficient system with rapidly increasing fuel prices and declining steam sales.

The inefficiency of the steam supply system arises from the fact that it was built under conditions of wartime austerity and at a time when energy conservation, and hence fuel price and efficiency of performance, were not the critical factors they are today. In this Section, the physical condition of the steam supply system and its fuel conversion efficiency are discussed.

## 4.1 - Physical Condition of Steam System

The Ajax steam supply system was built in 1942 and extended in 1957 and 1968. At the time it was designed, coal was essentially the only fuel available. Fuel oil was an essential war commodity and natural gas in Eastern Canada was still in the future. The boilers were later converted to fuel oil to take advantage of fuel price and ease of handling.

The steam distribution system was designed for operation at 150 psig steam and 468 degrees F to satisfy both high temperature process and low temperature heating loads. No provision was made for the return of condensate from the users.

An inspection of the system was carried out by Acres Shawinigan early in the study period.

### 4.1.1 - Boiler Plant

The steam is generated in six oil-fired boilers. Five of the boilers, which were installed in 1942 and 1958, were originally coal-fired and were converted to oil in 1965. The sixth boiler was installed in 1967 and is a package unit designed to burn oil or gas. There is space on the older boilers for the addition of gas-firing equipment.

In general, the condition of the boilers and auxiliary equipment was found to be good and the standard of maintenance satisfactory. An internal inspection of Boiler No. 5 was carried out with the boiler inspector. The fire side and water side surfaces of the pressure parts were in good condition. Some refractory damage required repair, however, this was considered not unusual for a unit that had been in continuous service for a year. The inspector confirmed that the condition of Boiler No. 5 was representative of the other boilers and he concurred with the Acres Shawinigan representative that, if the present maintenance procedures are maintained in the future, the boiler should give satisfactory service for at least the next 20 years.

### 4.1.2 - Steam Distribution System

The total length of piping in the distribution system is approximately six miles, the pipe sizes ranging from 12 to 1-1/4 inches diameter. Apart from a short section near the boiler house, where the 12 inch pipes are installed in walk-through tunnels, the entire steam distribution network is buried directly in the ground. Piping installed with the original system is insulated with 1-1/2 inches of thermobestos type insulation and wrapped in a waterproof tar paper. The newer piping extensions also have 1-1/2 inches of insulation but, instead of tar paper, the outer protective covering is a steel pipe.

Except where new connections have been made, the distribution piping has not been uncovered since it was installed. No serious underground steam leaks have occurred and it has been assumed that the system generally is in good condition. The local water table is understood to be below the level of the pipes, removing a common cause for insulation deterioration and pipe corrosion.

Inspection at the manholes revealed some deterioration of the insulation, mostly mechanical damage sustained when operation of shut-off valves or making piping connections have necessitated maintenance personnel entering the manhole. In one of the manholes on Clements Road West, the insulation was still missing following a recent new connection. It was scheduled for replacement in the near future.

A program of installation of new Triflex traps at all manholes is nearing completion. These traps appeared to be working efficiently with a minimum of steam loss.

Water drainage and conditions in the manholes varied. In some cases, the water had reached a level high enough to be in contact with the insulation, causing some deterioration. Whether the water had penetrated the insulation in the adjacent buried piping was not possible to determine by visual observation. If this is the case, heat losses from the piping would be greater than from unaffected pipe. Trial holes would be required to determine the extent of any damage and the potential for increased heat loss.

## 4.2 - Steam Supply System Performance

The system operating records were examined and the overall efficiency of performance determined. Calculations of theoretical efficiency were made to evaluate actual performance.

### 4.2.1 - Boiler Plant

None of the boilers is supplied with a combustion air preheater. It is also apparent that the boilers are operating with a fairly high level of excess air, especially in Boilers Nos. 1 to 5. Coal firing requires higher excess air than oil and it is more difficult to control excess air in units originally designed for coal and then converted to oil. Consequently, the average boiler efficiency is low, in the order of 78 per cent. Modern boilers designed for oil firing and provided with air preheaters and low excess air firing would achieve efficiencies of up to 88 per cent, a potential difference of 10 per cent.

Some of the steam generated in the boilers is used in boiler house auxiliaries including the deaerator, mechanical drive turbines and building and fuel oil heating. The balance of the steam is delivered to the distribution system.

On a yearly average, about 16 per cent of the steam generated in the boilers is used in the boiler house. This percentage varies by one or two per cent through the year as the temperature of the incoming city water and requirements for building heating change. It also varies slightly from year to year depending on whether the winters and summers are good or bad.

By means of a heat balance calculation, the theoretical amount of steam used in the boiler house was found to be 15.7 per cent of the generated steam. This suggests that the amount of steam used at Ajax for boiler plant auxiliaries is not excessive and is an inherent feature of its design.

Since no hot condensate is returned from the distribution system to the boiler plant, a major use for auxiliary steam in the plant is to heat the incoming city make-up water in the deaerator from 40 degrees F or less to 228 degrees F, the boiler feedwater temperature. If condensate at say, 180 degrees F could be returned to the boiler plant, calculations show that the auxiliary steam demand would fall from 15.7 per cent to 13 per cent. The fuel oil requirement would be reduced from the present 6.25 to about 5 gallons per thousand pounds of steam generated.

### 4.2.2 - Steam Distribution System

A calculation of the average theoretical heat loss from the steam distribution system, based on an assumed average steam saturation temperature in the piping of 400 degrees F and an average ground temperature of 40 degrees F, indicated an average hourly loss over the year of between 9 and 10 thousand pounds of steam as condensate. The average hourly loss determined from the steam plant records is in the order of 11,000 pounds per hour. This is a reasonable correlation and suggests that losses from the steam distribution are not excessive for the insulation thickness on the pipe.

If designed and installed today under the prevailing fuel economy, more than 1-1/2 inches of insulation probably would be applied and possibly the piping would be encased in one of the insulating backfill materials currently available on the market.

## 4.3 - Overall Efficiency

The efficiency with which the heat energy in the fuel fired in the boilers is converted to heat at the point of use is a product of three factors:

- the efficiency of the boilers;
- the amount of steam used in the boiler plant for auxiliary use;

- the amount of heat lost from the steam distribution system.

In the foregoing paragraphs, the average boiler efficiency is identified as 78 per cent. The average steam consumption in the boiler plant is about 16 per cent of that generated and, annually, some 21 per cent of the steam leaving the boiler house is condensed and lost to heat transfer to the surrounding ground. The product of these losses is approximately 52 per cent. In other words, only half the heat from the fuel fired in the boilers actually reaches the steam customers.

In comparison, a modern district heating system using a closed loop, high temperature hot water heat distribution system would operate at an efficiency approaching 80 per cent. The supply temperature of the hot water could be as high as 350 degrees F which is close to the useable saturation temperature of 150 psig steam in the Ajax system. The temperature of distribution and the amount of insulation would be designed for optimum efficiency with respect to distribution system heat losses.

## 5 - STEAM SYSTEM MODIFICATIONS

Since the increasing cost of fuel is a major casue of the problems facing Alliance, steps to improve the efficiency with which the steam supply utilizes this fuel are considered first. Improvement of efficiency can take place both in the boiler plant and in the distribution system, but only with the involvement of considerable capital expenditure.

### 5.1 - Boiler Plant

The efficiency of the individual boilers can be improved two ways, first by installing combustion air preheaters in the flue gas breeching to the chimney and, second, by modifying the fuel firing system to operate on low excess air.

#### 5.1.1 - Air Preheaters

The addition of air preheaters would improve the average efficiency of the boilers by approximately four per cent. This would mean that had these heaters been in place in 1976 when 300 million pounds of steam are expected to be sold, the total fuel oil purchase would be reduced by 161,400 gallons for a saving of $46,800.

To achieve the above fuel saving it would be necessary to invest approximately $600,000 in new air heaters, breeching and supports. The arrangement of the boilers with the forced draft fans located in the basement and the limited space between the back of the boilers and the boiler house wall would probably require that the air heaters be located on the roof together with extensive ductwork to complete the combustion air connections. New forced draft fans may be required on each boiler to accommodate the additional draft fan losses through the air heater, depending on the design margins allowed in the existing fans.

#### 5.1.2 - Low Excess Air Firing

When coal was originally burned in the Ajax boilers, the excess air would have been in the order of 35 per cent above the theoretical air requirement. This ratio was no doubt improved when the boilers were converted to oil though it still will be higher than is designed into modern boilers. Low excess

air operation, where the ratio is usually about three per cent, has three advantages. First, the formation of sulphur trioxide is reduced which helps to improve the quality of the flue gases discharged to the atmosphere. Secondly, the total amount of air to be handled by the boiler fans is reduced with a consequential saving in fan power. Thirdly, the quantity of fuel burned just to raise the temperature of excess air to that of the combustion products is reduced.

The modifications at the boilers would include new burners, each with its individual fuel and air metering and control equipment, and an oxygen sampling system at the flue gas exit of each boiler. Additional control equipment would also be required, using the flue gas oxygen readings to control the fuel-air mixture. It would be necessary to ensure that the boiler casing and settings are reasonably air tight to prevent the ingress of air into the furnace and bypassing the burner air supply.

The net improvement in boiler efficiency would be about 1-1/2 per cent which in 1976 would have resulted in a fuel saving of $16,000. The estimated cost of converting the six Ajax boilers to low excess air operation is estimated to be $520,000.

If both heaters and low excess air equipment were installed, and the combined efficiency improvement of 5.5 per cent obtained, it would require a total of $1,120,000 in capital investment to achieve a reduction of $63,000 in annual fuel purchases, based on average 1976 fuel costs. This represents a payback period of over 19 years to achieve a reduction in the 1976 steam cost of between 15 and 20 cents per thousand pounds of steam.

## 5.2 - Distribution

As discussed in Section 4, the magnitude of the heat losses from the steam distribution system are compatible with the calculation of expected losses. Some reduction in heat losses at the manholes could be achieved by repairing or replacing insulation and the effect of water in the manholes on adjacent buried piping could be checked. However, the reduction in heat loss that would result is a small part of the total system losses and would not result in a significant saving.

A major reduction in heat loss could be achieved by replacing the existing 1-1/2 inches of insulation with, say, 3 inches and, where the outer covering on the

insulation is tar paper, replacing it with a steel pipe. The losses could probably be halved in this way but at very considerable capital outlay. The installation of a condensate return system would also reduce fuel consumption in the boiler plant by about 10 per cent but again at very considerable expense. In addition, ongoing maintenance costs could also be greatly increased.

## 5.3 - Alternate Fuels for the Boiler Plant

The cost of the fuel oil presently burned in the Ajax steam plant is equivalent to $1.61 per million Btu. Other fuels which could be burned in the boilers are coal or natural gas.

Notwithstanding the price of coal, be it more or less than oil, the cost of rehabilitating the steam plant to burn coal would be unacceptably high. Not only would the coal and ash handling system need to be restored but new air pollution control equipment would be required to ensure compliance with provincial legislation prevailing today. The recovery of the investment would entail annual costs considerably in excess of any potential reduction in fuel cost. For this reason, coal is not considered further in this report.

The present cost of natural gas is equivalent to $1.59 per million Btu. The cost of adapting the boiler for gas firing would be in the order of $300,000. However, the boiler efficiency could be reduced by as much as three per cent, negating any savings due to lower unit fuel cost. Moreover, under present government policies, the prices of fuel oil and natural gas are expected to reach parity in the future. This would result in no fuel savings. The major advantage of installing the gas supply train and burners would be flexibility, permitting burning oil or gas at any time, whichever is the most advantageous.

## 5.4 - Summary

Modifications could be made to the boiler plant to improve its efficiency but the resulting cost benefits would not be sufficient to reduce the selling price of the steam to a point that it would even approach the current competitiveness of natural gas. Except for the flexibility in the choice of fuel provided by gas, there is no advantage to adapting the boilers to burn an alternate fuel.

As far as improving the efficiency of the steam distribution system significantly is concerned, the potential fuel savings would be far outweighed by the fixed charges on capital invested in the necessary modifications.

In general, therefore, measures to improve the fuel utilization efficiency will not make any effective contribution to the viability of the Ajax steam supply system.

# 6 - ENVIRONMENTAL CONSIDERATIONS

## 6.1 - Air Pollution

At the present time, the boiler plant is served by two chimneys. The main, 150 feet high chimney, was built in 1942 and serves the five boilers which originally burnt coal but now burn oil. A separate 60 feet high steel chimney serves the sixth, package boiler which was installed in 1967.

When a residual oil containing about 2.5 per cent of sulphur is being burnt, the calculated impingement concentrations of contaminants produced by either of the two chimneys at nearby apartment buildings are above the levels permitted in provincial legislation. The Ontario Ministry of the Environment have suggested to Industrial Steam that, by increasing the height of the main chimney to 210 feet and connecting the smaller chimney to it, the impingement concentrations would be reduced to acceptable levels.

The total cost of the chimney modifications will be not far short of $300,000 which would impose a further financial hardship on the operation of the steam plant in view of the rate of return allowed by the Ontario Energy Board rulings.

The problem of unacceptable conditions caused by the existing steam plant chimneys could be reduced by burning an oil containing 1 to 1.5 per cent sulphur compared with the 2.5 per cent sulphur oil being burned now. This could result in reducing the required increase in chimney height or eliminating the increase altogether. However, a premium of 1.5 to 2 cents per gallon would have to be paid for by the low sulphur fuel and this would mean an increase of $50,000 to $65,000 in annual fuel costs.

The maximum gain would be if the chimney extension could be dispensed with entirely and the associated investment of $300,000 avoided. If an annual rate of 10 per cent of capital cost is assumed for interest, depreciation, etc., the annual fixed charge of $30,000 which could be avoided is less than the additional annual cost of the low sulphur fuel. The conversion to a low sulphur fuel would not, therefore, be feasible economically.

## 6.2 - Oil Farm Dykes

Though not primarily an environmental matter, there could be a requirement that Industrial Steam construct dykes around their three oil tanks in accordance with fire

safety codes. However, these dykes would also avoid spilling of oil to ground drainage system in the event of tank leakage.

The cost of these dykes is estimated to be $40,000 to $50,000 which would be an additional financial hardship.

# 7 - FINANCIAL MANAGEMENT

## 7.1 - General

Industrial Steam Limited (ISL) is owned jointly by Alliance Building Corporation Limited and Goldfan Holdings Limited. ISL is managed by Alliance Building Corporation Limited where it is the responsibility of Major Charles A. Coull, Manager, Corporate Affairs.

The corporate structure immediately involving ISL is shown on Figure 7.1. The distribution of ISL share ownership is shown below.

Industrial Steam Limited--Shares

| | Preferred | | Common | |
|---|---|---|---|---|
| Authorized | 135,000 - 5 per cent non-cumulative redeemable, voting P.V. $10.00 | | 2,000 No P.V. | |
| Issued | Alliance | 100,137* | Alliance | 150 |
| | Goldfan | 33,439* | Goldfan | 50 |
| | | 133,576 | | 200 |

*Held in trust for Duffins Creek Estates Limited.

It is understood that Alliance acquired ISL as part of an investment acquisition in 1972 and has continued to operate ISL, essentially unchanged, since that time.

## 7.2 - Steam Rate Structure

ISL distributes steam for both heating and process purposes to approximately 53 customers within the Town of Ajax, Ontario, in accordance with a licence issued by the Town for a period of 20 years ending February 1, 1980. The licence may be extended by the Town for further periods not exceeding 20 years at any one time.

Under the terms of the contract, ISL must prepare a tariff of maximum rates for steam and apply to the Ontario Energy Board for approval of this tariff if requested in writing by the Town. The Town has twice required that such application be made resulting in Board Orders E.B.R.O. 330 dated April 14, 1975, and E.B.R.O. 347 dated June 1, 1976. Both Orders approved tariffs of maximum rates. E.B.R.O. 347 approved rates for the period May 1, 1976, to April

30, 1976, and is shown in Table No. 7.1. The tariff of maximum rates now in effect and allowed by the escalation clause and other terms contained in Order E.B.R.O. 347 is shown in Table No. 7.2.

ISL is the only steam supply company in Ontario which can be compelled to have its rate structure approved by the Ontario Energy Board.

## 7.3 - Basis for the Approved Rate Structure

Detailed calculations and tables relating to the determination of rate of return, etc., are contained in Appendix 3 to this report. The Ontario Energy Board (OEB) based the steam rates approved in E.B.R.O. 347 on:

(1) The Income and Expenditure Accounts of ISL for the years 1970 to 1977, with 1975 adjusted to delete financial operations not associated with steam plant operation and the income and expenditures for 1976 and 1977 being forecast by ISL. (See Table A3.1.)

(2) December 31, 1976, Fixed Assets of ISL as projected by the Company and submitted in Amendment 2, Exhibit 7E to their rate application. (See Table A3.2.)

The OEB saw fit to reduce the rates applied for by ISL by an average of $0.45 per 1,000 pounds of steam. This was calculated by annualizing the income and expenditure streams and forcing out an excess revenue. Full allowance was given for the higher steam rates and for a return of 10 per cent on a deemed rate base of $1,000,000. (See Tables A3.3 and A3.4.)

The rate base was calculated by the OEB as shown in Table A3.5. To the Company's forecast of $823,000 in fixed assets at December 31, 1976, was added a working capital allowance (inventory, accounts receivable, etc.) of $81,940 to yield a total of $904,940. The Board then concluded that the Company's deemed rate base for the full year of 1976 should be $1,000,000.

ISL did not specify or request a desired rate of return on its capital employed in steam operation. Accordingly, the Board adopted the aforementioned figure of 10 per cent on the deemed rate base of $1,000,000, that is, $100,000 as being an appropriate rate of return to ISL. A rate of 10 per cent is consistent with rates allowed major public utilities in June 1976. In particular, Union Gas received 10.14 per cent on rate base, and Consumers Gas received 10.08 per cent, in decisions handed down by the OEB on June 30, 1976.

As noted above, details of the calculations of return are shown in Tables A3.3, A3.4 and A3.5. These calculations also reflect the income tax payable method of tax accounting and the Board's opinion that ISL will continue to operate in a non-taxpaying fashion.

The forecast net earnings for 1976, as shown in Table A3.1, were $68,000. Subsequent to the issuance of E.B.R.O. 347, however, the Company calculated the effect of the Order on earnings and found that earnings for 1976 would be reduced to $34,000 with the allowed rates in effect. That calculation is shown in Table A3.6. Although steam sales have exceeded expectations recently, and may render that forecast pessimistic, only a year-end audit will verify the forecast and determine the actual rate of return on the deemed rate base.

## 7.4 - Economic Viability of ISL

ISL is in a position which is common to all industry today--faced with rapidly increasing energy costs and with few alternatives available. ISL, however, is in a particularly difficult position because it is in the business of converting one form of energy (oil) to another (steam) and selling the steam with conversion and distribution losses (costs) factored into the selling price. The cost of raw material (oil) to the process has risen from 44 per cent of operating expenses in 1970 to a forecast 68 per cent of expenses in 1976. That percentage will reach 70 to 72 by 1980 at current levels of oil consumption.

ISL is also in the position of having to have its steam selling rates approved by a regulatory body if that is deemed necessary by its (ISL's) licencor--The Town of Ajax. Thus, ISL is perpetually exposed to the regulatory lag which is all too often implicit in having to apply for, support in hearings, and gain approval of new rates.

Compounding ISL's difficulties is the fact that its customers are finding it increasingly attractive to convert from steam heat to natural gas, the economics of which are evident in Table 3.2 to this study (Comparison of Alternative Heat Costs).

Summing up the variables which affect the economic viability of ISL's steam operations, we may conclude that ISL is caught in a classic cost squeeze. An old, inefficient process, for which the raw material costs are increasing at a faster rate than any other process input, is no longer competitive when compared with alternate processes to which current customers have relatively ready access. There are technically viable means by which the process may be improved but they are not economically viable.

Although the rate of increase in the price of fossil fuels which might logically be used in the ISL plant is a matter for conjecture, the trend upward is definite. The concensus view of oil producers and governments of producing provinces is that the price for Canadian domestically-produced crude oil, in particular, must reach "world levels" by 1980/81. Meanwhile, the federal government has enunciated a national energy strategy (An Energy Strategy for Canada: Policies for Self-Reliance, tabled by the Minister for Energy, Mines and Resources, April, 1976) which would "... move domestic oil prices towards international levels; and to move domestic prices for natural gas to an appropriate competitive relationship with oil over the next two to four years". Given the apparent propensity for international oil prices to move up, the efficacy of the policy is open to question.

The price of oil in the United States--our major trading partner--is critical to the competitiveness of Canadian manufactured exports, and will have some impact on Canadian oil pricing policy. The price of oil in the U. S. is now governed by legislation and is set by blending the prices of imported and domestically produced oil. The U. S. price escalation program will cause oil prices at Chicago to rise from about $10.90 per barrel at present to $13.50 in early 1979. Escalations beyond that point are certain, but their magnitude are unknown. They will be related, however, to international oil prices which are at present represented by $11.51 per barrel for Arab Light "marker" crude, F.O.B. the Persian Gulf. International prices are very difficult to forecast, but will likely increase at the rate of average inflation in industrialized nations at a minimum.

In early April, 1976, the Government of Ontario recommended that the national price for oil be a blend of the prices of "old" oil (at a prevailing well-head price of $8.00 per barrel), "new" oil (at a price high enough to encourage new developments), and imported oil. That approach would have resulted in a $0.20 per barrel increase on July 1 rather than the $1.05 actually implemented. The Government of Ontario still favours development of an approach which would raise oil prices at a rate slower than that now apparent in Federal Government policy.

From the above, it is evident that policies of government as related to oil price are varied and subject to both internal and external forces. Decision-makers are at presently poorly guided on energy-related matters.

For the purpose of this study, some assumptions have been made regarding fuel prices. For instance, if domestic crude oil reached $14.50 per barrel in 1980 and there was still some oversupply in the Eastern Canadian Heavy Fuel Oil market, heavy fuel oil cost to ISL could reach $0.45 per gallon. Assuming moderate escalation of all other

costs, ISL's heavy fuel oil bill could exceed 70 per cent of total operating costs. The price of ISL's steam would have to increase by $1.80 per 1,000 pounds due to higher fuel costs alone. Other cost increases could add $0.60 per 1,000 pounds of steam. The total increases will likely exceed those for alternate heat sources (individual hot air or steam furnaces).

If it is assumed that no capital additions are made to the plant, the return component allowed by the OEB and factored into the steam costs would not likely increase (despite some growth in working capital requirements). Meanwhile, however, each year ISL will likely be required to submit new rate applications to the OEB, incur the cost of hearings and relinquish revenue awaiting OEB decision on the rates.

Given this situation, it must be concluded that the future holds for ISL the prospect of diminishing demand for its product, increasing costs and under-recovery of allowed rates of return on rate base.

## 7.5 - Operation of ISL as a Public Utility

There are several factors which recommend the operation of the existing ISL plant as a public utility--even if only for a few years.

The first is that the revenue requirement per unit of steam could be reduced by about 10 per cent since municipal taxes and the return on equity component could be eliminated from the cost of services (see Cost of Services calculation for year ending December, 1976, Table A3.1.). These reductions would, however, be offset by the loss of tax revenue by the municipality and the interest costs for money which the public administration would need to borrow to buy the plant. All customers, private and public, could, however, benefit from lower costs of service.

Secondly, the threat of loss of steam supply to public buildings in Ajax which are now supplied by ISL would vanish. Altogether, it may make the current crash program to replace the steam with natural gas heat supply systems unnecessary--at least in the near term.

Thirdly, with supply assured and some relief on costs available, there would be time for a considered appraisal of the many alternatives open to the Town of Ajax. There may be sufficient incentive for the public administration to freeze the price of steam until that appraisal was completed and some policy/planning decisions were made. Such action would surely gain the support of the majority of

customers, halt the erosion of the steam demand, and thereby enhance the economics of continued operation.

Lastly, the opportunity would be gained to integrate more fully the planning of growth in the Town of Ajax. At present, the steam plant must be somewhat of a question mark hanging over development plans.

There is some evidence that industrial and commercial concerns are now more influenced by locational factors (access to market, labour, transportation, etc.) and general economic conditions than availability of steam supply when considering Ajax as a new operational site. The previously advertised availability of steam to industrial sites is much less a selling feature of Ajax property than it once was. Nevertheless, continued operation of the steam plant must be a factor in the planning deliberations of both private concerns and public institutions.

Public ownership of the steam plant would provide increased opportunity to plan the growth expected in Ajax predicated on assured continued operation of the steam plant and the phased development of new steam supply policies and facilities.

The development and assigning of responsibilities among local, regional and provincial government authorities as regards Ajax is still very much an on-going process. Accordingly, no specific recommendation is made here as to which level of government should administer the steam plant.

TABLE 7.1

INDUSTRIAL STEAM LIMITED

TARIFF OF MAXIMUM RATES TO BE CHARGED
FOR THE SUPPLY OF STEAM
IN THE TOWN OF AJAX, ONTARIO
WITH EFFECT FROM MAY 1, 1976

| Heating Steam | Including Process Users of 500,000 lbs. or less per month | Per 1,000 lbs. |
|---|---|---|
| 1. First Rate | First 50,000 lbs. per month | $5.64 |
| 2. Second Rate | Next 50,000 lbs. per month | $5.46 |
| 3. Third Rate | Next 100,000 lbs. per month | $5.22 |
| 4. Fourth Rate | Thereafter | $4.69 |

| Process Steam | Process Users Exceeding 500,000 lbs. per month | |
|---|---|---|
| 1. Consumption Charge | | 4.43 |
| 2. Demand Charge | Charge to the peak hour of demand during the month per lb. | 16.52¢ |

By Order of the Ontario
Energy Board, June 1, 1976

1. The above commodity rates shall increase or decrease by 1.12 cents per 1,000 lbs. for every 0.1 cent per gallon increase or decrease in the cost of fuel oil supplied to ISL, compared to the cost paid on December 31, 1975.

2. Minimum monthly charge--10 per cent of highest billing in previous 12 months.

3. Delayed payment penalty--10 per cent of the amount billed if the bill is not paid within 20 days of its rendering.

4. The approved tariff of maximum rates shall be applied uniformly to all customers.

## TABLE 7.2

## INDUSTRIAL STEAM LIMITED

### TARIFF OF MAXIMUM RATES TO BE CHARGED FOR THE SUPPLY OF STEAM IN THE TOWN OF AJAX, ONTARIO WITH EFFECT FROM SEPTEMBER 1, 1976

| Heating Steam | Including Process Users of 500,000 lbs. per month | Per 1,000 lbs. |
|---|---|---|
| 1. First Rate | First 50,000 lbs. per month | \$5.83 |
| 2. Second Rate | Next 50,000 lbs. per month | \$5.65 |
| 3. Third Rate | Next 100,000 lbs. per month | \$5.41 |
| 4. Fourth Rate | All over 200,000 lbs. per month | \$4.88 |

| Process Steam | Process Users Exceeding 500,000 lbs. per month | |
|---|---|---|
| 1. Consumption Charge | | 4.42 |
| 2. Demand Charge | Charge to the peak hour of demand during the month per lb. | 16.52¢ |

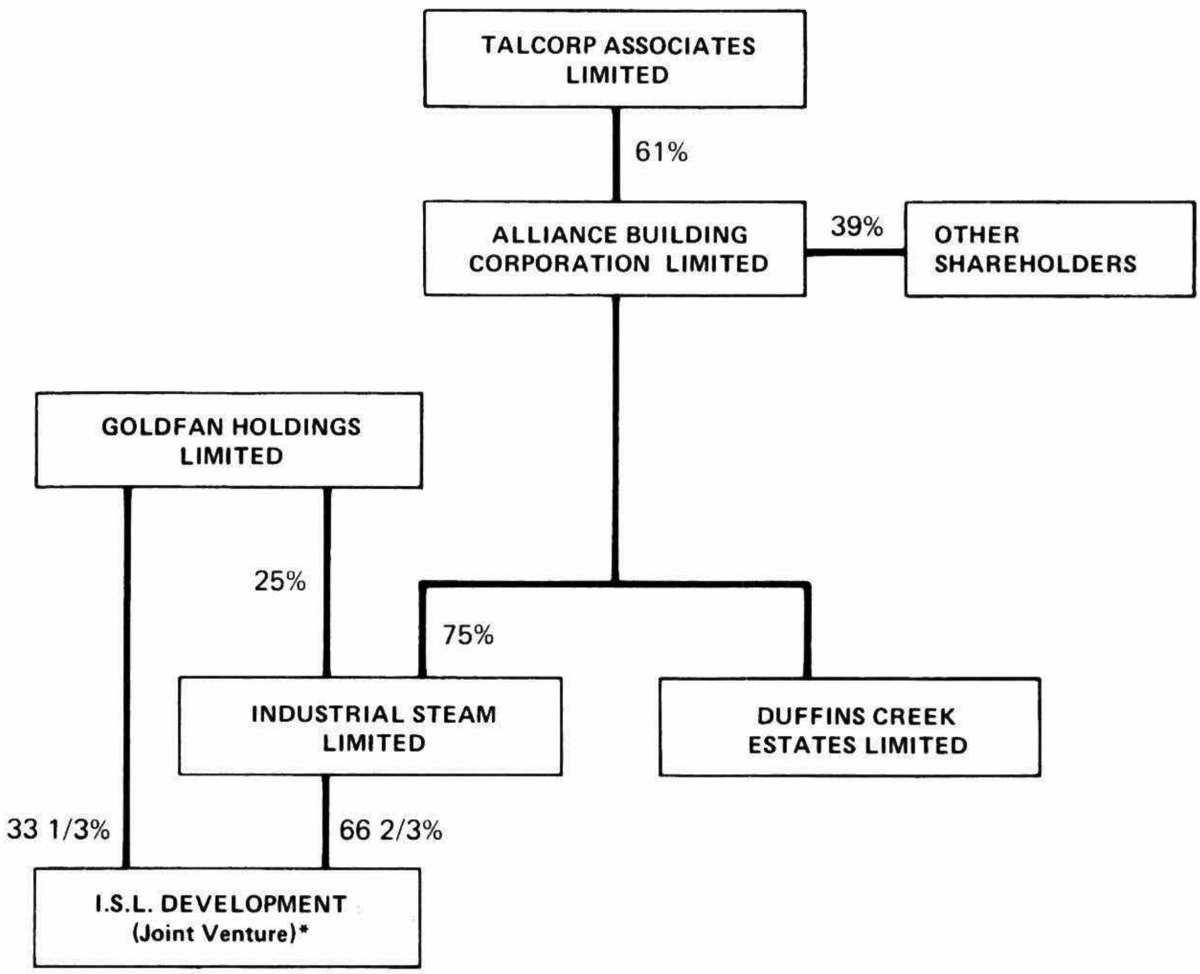
By Order of the Ontario Energy Board, June 1, 1976

1. The above commodity rates shall increase or decrease by 1.12 cents per 1,000 lbs. for every 0.1 cents per gallon increase or decrease in the cost of fuel oil supplied to ISL, compared to the cost paid on December 31, 1975.

2. Minimum monthly charge--10 per cent of highest billing in previous 12 months.

3. Delayed payment penalty--10 per cent of the amount billed if the bill is not paid within 20 days of its rendering.

4. The approved tariff of maximum rates shall be applied uniformly to all customers.




*I.S.L. Joint Venture Development's Interests
– 50% Alliance Building Corporation Limited
– 50% Goldfan Holdings Limited

ACRES SHAWINIGAN LIMITED

Client ONTARIO MINISTRY OF THE ENVIRONMENT

Project AJAX STEAM PLANT VIABILITY STUDY

Title CORPORATE AFFILIATIONS INDUSTRIAL STEAM LIMITED

Date DECEMBER 1976 Fig. No. 7.1

# 8 - REFUSE AS AN ALTERNATE FUEL SOURCE

In Section 5.3, the use of natural gas or coal as alternates to fuel oil is discussed and the conclusion drawn that neither are feasible as a means of effectively reducing the steam selling price.

A third alternate could be municipal refuse from Ajax and the surrounding area. At the present time, landfill is the only means available in the Durham Municipal Region for the disposal of municipal refuse. A recent study[1] carried out for the Region projected the total amount of refuse to be dealt with in the Ajax area by the year 1980 would be about 245 tons per day.

The use of refuse as a fuel for district heating systems has been practiced in Europe for many years. It is becoming common in North America and there are at least three large Canadian steam generating incinerator plants in operation in Hamilton, Montreal and Quebec City. A fourth has been proposed for Toronto. Typically, in North America up to three pounds of steam can be generated from one pound of refuse.

## 8.1 - Incinerator Capacity

Reference to Figure No. 8.1 shows a year-round base steam load of about 20,000 pounds per hour in Ajax. This load would support an incinerator converting 80 tons of refuse per day and operating at a capacity factor approaching 100 per cent. However, an 80 ton per day unit would not be an economic size essentially due to the relatively high unit installation cost.

A 250 ton per day unit is probably the smallest capacity that would be built. The steam generating capacity of 62,500 pounds per hour would be about the same as the average winter hourly steam demand. The capacity factor that could be obtained from a 250 ton per day unit when supplying the Ajax steam system would not be much more than 50 per cent.

## 8.2 - Location of Incinerator

The site for a steam generating incinerator should be as close to the load centre of the steam distribution system as possible. For the purposes of the study, a site adjacent to the Duffins Creek, approximately 400 yards south

of Bayly Road, as indicated by Figure No. 8.2, was selected. Truck circulation could be from Valley Road through the incinerator plant to Fuller Road. This would require major refuse truck traffic through industrial areas only, remote from the residential subdivisions. Connection to the steam distribution system would be by means of an 8 inch diameter steam line to the existing 8 inch line which runs south from Bayly Road along the CN rail tracks to serve Precision Valve.

It is anticipated that the ash from the incinerator would be disposed of to the existing landfill site to avoid possible leaching of heavy metals to the nearby Duffins Creek and to minimize the use of potential industrial land for waste disposal.

There is adequate area for the 250 ton unit, and if extension of the incinerator plant was ever found necessary for any reason, three more similar units could be accommodated to the same time.

## 8.3 - Incinerator Plant Arrangement

The evaluation of refuse as an alternate fuel has been based on the "on-grate" mass burning type of incinerator for which a considerable amount of experience has been accumulated. Other types of incineration such as pyrolysis and suspension firing are mainly at the commercial prototype development stage and were not considered in depth at this time. However, based on experience to date, these developing systems promise attractive capital and operating costs when burning selected refuse and they should be included in any detailed study of refuse heat recovery.

As shown in Figure No. 8.1, the incinerator would be operated for a short time during winter at full steam generating capacity, the balance of the steam supply system demand being provided from the existing steam plant. For most of the year, as the steam demand falls below the incinerator capacity, it would be operated to match the demand. Since there would still be refuse landfill sites in operation in the Region, it is assumed that they would continue to accept the refuse surplus to the incinerator requirements.

The existing oil-fired boiler plant would be used to meet the peak demands in the winter months and for emergency operation in the event of problems in the incinerator plant. It would also provide standby capacity during scheduled or forced incinerator maintenance. It is possible that the existing boilers could be relocated at the incinerator plant site, thus avoiding the expense of two operating staffs and releasing the area of the existing steam plant for real estate development.

## 8.4 - Capital and Operating Costs

Based on 1976 dollars, the costs of building a single unit, 250 ton per day steam raising incinerator plant and the cost of its subsequent operation were estimated. A cash flow table covering the initial construction period and ongoing operation over a plant life of 20 years was prepared.

### 8.4.1 - Steam Sold From Incinerator

Assuming that for each pound of refuse burnt three pounds of steam are made available at the incinerator boundary, the steam sold from the plant would be about 217 million pounds per year. This quantity is based on a potential capacity factor of incinerator operation of 67 per cent. This factor is reduced by 25 per cent to provide for scheduled and unscheduled outages and by a further 21 per cent for losses from the steam distribution system. This last factor is based on the performance of the Ajax system to which the incinerator will be connected and is a substantial penalty on economic performance.

### 8.4.2 - Refuse Handling Revenues

Revenues from charges for handling of the refuse were assumed to be $6.70 per ton which is the cost of disposal to landfill contained in the Durham Region waste management study. At the present time, the Town of Ajax contributes 50 per cent of this cost of $3.35 per ton.

A similar allowance of $6.70 per ton charged to the incinerator was assumed for disposal of the ashes to landfill.

Using the cash flow as the basis of a computer test program, the selling price of steam necessary to achieve various rates of return was calculated. The results of these calculations can be summarized, in 1976 dollars, as follows:

| Rate of Return on Capital Per Cent | Required Revenue $ per 1,000 Pounds of Steam |
|---|---|
| 0 | $ 4.30 |
| 5 | 6.49 |
| 10 | 9.08 |
| 15 | 12.26 |
| 20 | 15.57 |

The assumption used in preparing the cost estimates and the rate of return calculation are as shown in Appendix 4 of this report.

## 8.5 - Feasibility of Refuse Heat Recovery

It is evident that the steam selling prices required to achieve even moderate rates of return are considerably higher than the rates contained in the current steam tariff. Under the general policies of the Ontario Energy Board concerning rate of return, building and operating a steam generating incinerator in Ajax would not be attractive to a private operator.

Public ownership by, for instance, the Town of Ajax, may have advantages of tax exemption and the ability to operate at low rate of return on investment. In this case, the steam selling price could be between four and five dollars in todays' terms. Even at this price, steam would not be the preferred source of heat for many existing steam users compared with the installation of their own heating plant.

It should be emphasized that the above cost analysis is based on todays' costs and compared with today's fuel prices at the existing boiler plant. In fact, even if started today, the incinerator would not be operative until about 1979 to 1980. During this time, the cost of fossil fuels will have risen considerably under the present climate of energy conservation and international oil supplies. It is to be expected that these costs will continue to rise beyond 1980.

However, the costs of the steam from an incinerator plant would be largely inflation proof once established at the start of plant operation. Annual charges on capital would be a major, constant component of the steam cost. The varible component of the cost would comprise operating labour, supplies and maintenance, and would experience some escalation over time. It would be assumed that the rates charged for the steam and the refuse handled would be fairly apportioned to both steam users and those gaining access to the disposal facility.

The cost of steam from the incinerator plant may or may not be competitive initially with steam generated from fossil fuels, either in the steam plant or by individual users. This will depend on the current price and availability of natural gas and residual fuel oils. If the incinerator steam is not competitive in 1981, when it probably would start operation, it may be within a few years as fossil fuel prices continue to rise or their availability become limited. In this case, a rate

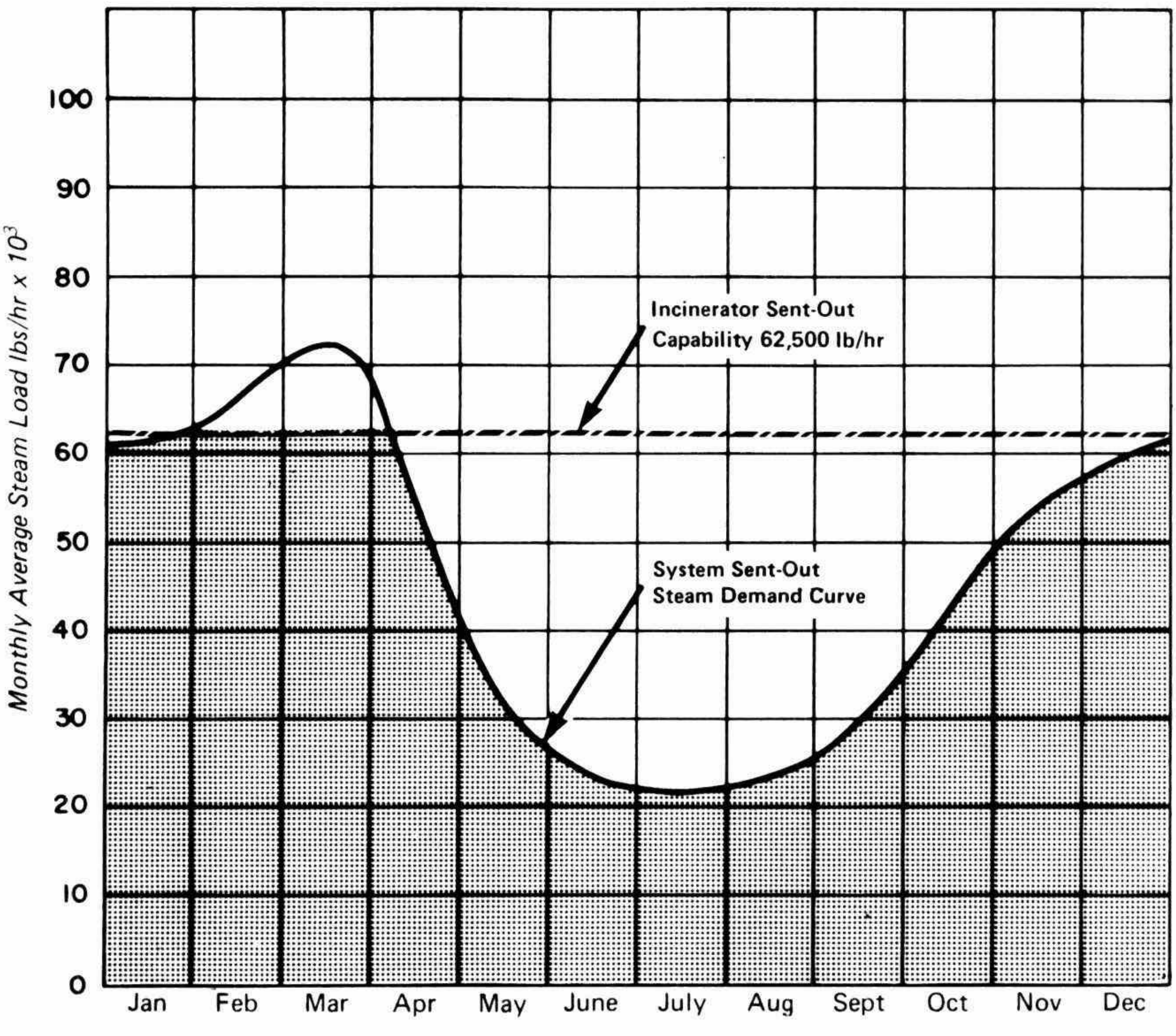
structure could be devised to subsidize the plant operation in the early years to maintain a competitive steam price and recover these subsidies in later years when the margin between the steam costs from the two fuel sources permit.

In summary, operation of a privately owned and operated steam generating incinerator located in Ajax to serve the existing steam supply system would not be viable. It may be feasible provided tax exemption and other economic advantages available to a public entity continue in the future and if trends in cost inflation and fossil fuel pricing are taken into account.

In any assessment of refuse incineration as a heat source, it would be necessary to take into account the present conditions surrounding the operation of the existing steam plant, making provision for continued operation until 1981 or when the incinerator plant becomes operable. This may include operating subsidies to prevent further defection of steam customers to gas. Repayment of these subsidies would presumably be included in the overall cash flow analysis.

Practical steps to dissuade further defection to natural gas could include restricting operation of the steam system to the northern area as discussed in Section 3.2.3, or installing temporary gas fired boilers at the user's plants.

If further consideration is given to refuse heat recovery, it probably should be directed to policies affecting operating subsidies from various government levels that may make operation viable in the short term. Without these possibilities, further detail feasibility study could not be justified.



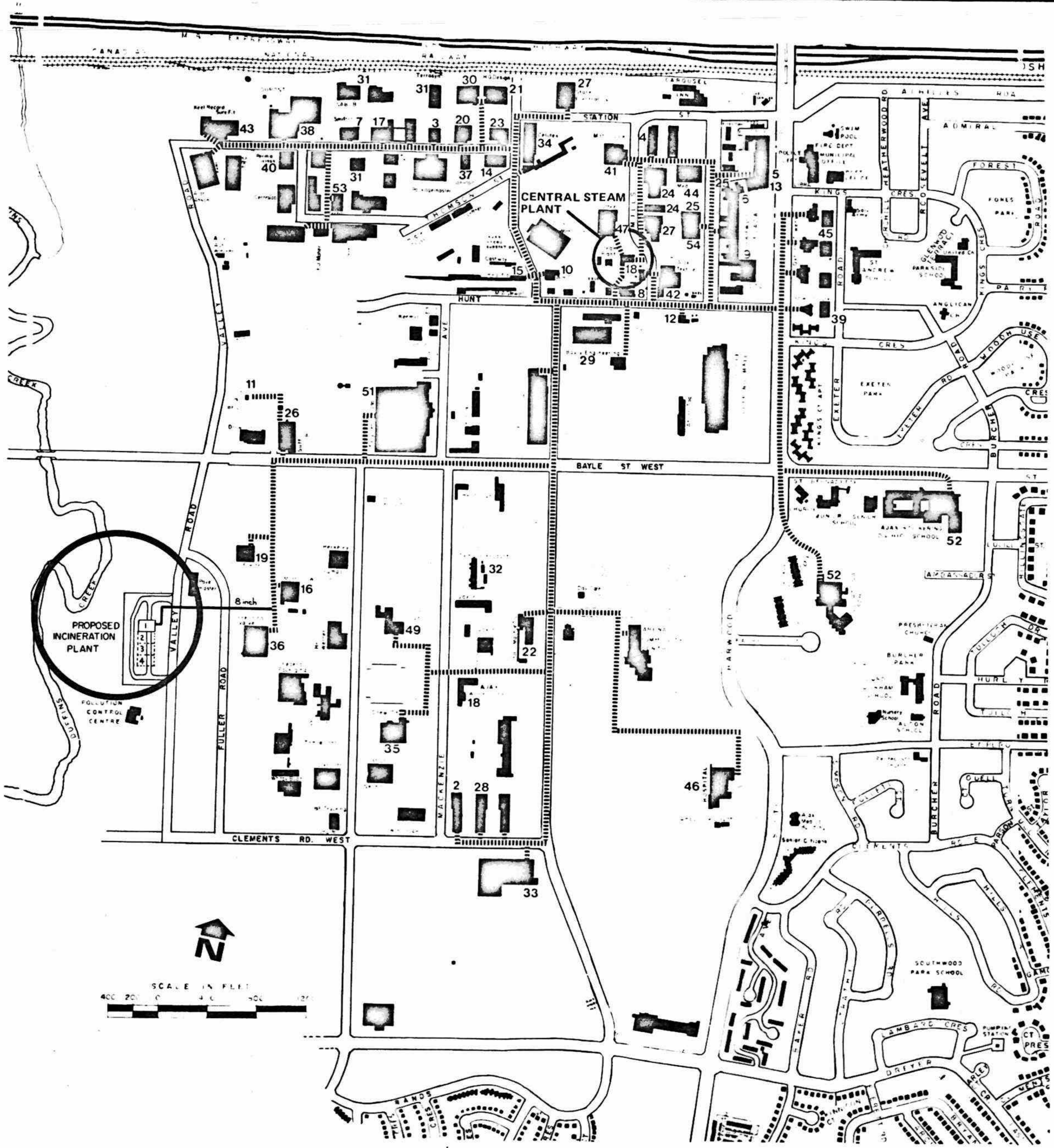

ACRES SHAWINIGAN LIMITED

Client ONTARIO MINISTRY OF THE ENVIRONMENT

Project AJAX STEAM PLANT VIABILITY STUDY

Title HEAT BALANCE DIAGRAM INCINERATOR STEAM LOAD CURVE

Date DECEMBER 1976 Fig. No. 8.1




**LEGEND**

steam distribution piping

28 reference numbers relate to steam customers as listed in table 3.1

**ACRES SHAWINIGAN LIMITED**

| | |
|---|---|
| Client | ONTARIO MINISTRY OF THE ENVIRONMENT |
| Project | AJAX STEAM PLANT VIABILITY STUDY |
| Title | OUTLINE OF DISTRIBUTION SYSTEM WITH INCINERATOR PLANT |
| Date | DECEMBER 1976 |
| Fig. No. | 8.2 |

## 9 - THE FUTURE

Though, technically and economically, continued operation of the steam plant does not seem justified at the present time, there are two conditions that possibly could arise in the future that might give at least some strategic value to its retention. There are: firstly, policy restrictions on the burning of natural gas or light oil by commercial and industrial users because of supply constraints and, secondly, a growth of the steam demand in line with the population trends predicted for the Ajax area.

### 9.1 - Impact of Fuel Supplies

Over the past few years much has been said about the depletion of Canadian fossil fuel resources and the inability of known reserves to meet Canadian demands. Deficiencies in both oil and gas supply are expected in the early 1980's. In this event, the use of fuels will probably become increasingly regulated by either price or legislation to ensure that natural gas will be used only by those facilities unable to burn heavy oil or coal economically.

If the above were a firm prediction supported by a definitive national fuel policy, many of the Alliance steam customers now assessing conversion to gas might reconsider. At least there would be the threat that, when natural gas or light oil costs become prohibitive compared with Bunker C fuel, or if there are prohibitions on burning these fuels, they would have to return to steam under the terms set by the steam plant operator. This would apply mainly to steam users whose operations are expected to continue beyond the 1980's. Meanwhile, by converting to gas there could be a net saving in heat cost in the short term for some customers, particularly those whose operations do not have a long life or are particularly sensitive to economic conditions.

The temptation to convert to gas has been increased in the last few months by the attractive contracts being offered by the gas utilities. The sale of gas by these utilities has been adversely affected by the general economic turndown and they are feeling the effects of the "take or pay" contracts they maintain with TransCanada Pipelines. Statements to the effect that there is plenty of gas, at least until 1981, makes predictions of future shortage hard to accept for the enterprise for which existence cannot be predicted as far as the 1980's or which wants to achieve the maximum cash flow in the shortest time without regard for the longer term future. It should be pointed

out here, however, that natural gas is more readily available than previously forecast because higher prices have motivated producers to develop known resources at a rate faster than anticipated. Total supply potential has not dramatically improved--only producibility from known, conventional producing areas has been enhanced for the short term.

## 9.2 - Fuel Policies

As noted above, the extent of the oil and natural gas resources in Canada and how long they will last at predicted levels of demand vary according to the sources of information, be it the oil companies, the ecologist or the various levels of government. At the moment, no formalized, generally accepted policy exists to guide the utilization of these resources or their allocation; hence, no specific guidelines are available for assessing a course of action involving the use of a specific fuel.

The best official guidance on the future availability of hydrocarbon fuels is enunciated in the National Energy Board documents "Canadian Natural Gas: Supply and Requirements", April, 1975 and "Canadian Oil: Supply and Requirements", September, 1975. The estimates in those documents have been revised little to date, but have been challenged to some degree by proponents of heavy oil and tar sands recovery schemes.

However, notwithstanding the different opinions, it is generally acknowledged that the Canadian oil and gas reserves are not the infinite resource they were assumed to be only a few years ago. At predicted levels of consumption they could effectively be exhausted in the next decade or two. Meanwhile, Canada will become increasingly dependent on imported oil. What effect could this have on the Ajax industrial and commercial communities? Though there is no definitive answer, the following might be the situation as far as Ajax is concerned.

Assuming the conventional Canadian oil and gas reserves became severely depleted within the next 10 to 15 years, it is probable that the use of these two fuels would become progressively more regulated, first by price deterrents to consumption and ultimately by legislation. These restrictions would continue at least over the short term to accommodate an interim shortfall until gas is made available from the frontier sources.

The deterrent measures would be intended to divert light oils and gas to the residential user or to strategic processes which are dependent on their use. Other large installations would be forced to use heavy oil on the basis

that they are equipped to burn them and are in a better position to control their impact on the environment. Under these circumstances, coal, either from the U. S. A. or Western Canada could become attractive also, even for small industrial and central heating installations.

If the Ajax steam plant is shut down in 1980 and the steam customers replace it with natural gas, most of them could be faced later with converting to heavy fuel or coal with the associated fuel handling system, air pollution control equipment and increased operating and maintenance costs. Another alternate may be to rehabilitate the present Ajax steam system or build a new, modern central heating plant using high temperature hot water as the heat distribution medium. Whatever is required, there will be a financial upheaval for all concerned.

For these options to have any effect at this time on the decisions to convert to gas now being made by some of the larger steam customers, it would have to have the force of a government fuel policy whereby the results of their action can be evaluated now and related to their long term objectives. Unfortunately, no such national policy exists nor is any implied policy strong enough or definitive enough to cause users to have second thoughts, especially in light of the strong selling campaigns being mounted by the natural gas utilities and their promises of unlimited gas until at least 1981.

Any consideration of the strategies of resource conservations that might affect Ajax, especially the use of energy forms imported into Ontario, presumably would be the prerogative of the Government and its Ministry of Energy.

## 9.3 - Future Load Growth

A recent study conducted by the Planning Department of the Region of Durham predicted both residential and employment population growth for designated urban growth areas within the Regions. Of particular interest is growth area No. 22 which is essentially the area now served by the Ajax steam plant. There, an employment growth of over 400 per cent is predicted between 1975 and the year 2000. If the requirement for industrial and commercial heat is assumed proportional to the employment population growth, then, theoretically, the load density could be increased from the 0.16 million Btu per hour per acre to 0.64 million Btu. This is a little more than the current European criteria for economic feasibility of district heating systems.

However, the realization of population predictions can be affected by many factors--both economic and strategic--and the year 2000 is quite distant when predicting population and load density in any way which could be used effectively in assessing the viability of the steam plant. Even in the immediate future, Alliance have no potential new clients who could dramatically increase the demand for steam. The Town of Ajax continues to seek new industries for the area but sees no significant increase in the foreseeable future, largely due to the current depressed economic conditions and projections.

# 10 - IMPACT OF STEAM PLANT SHUTDOWN

At the present time, the return on investment allowed by the Ontario Energy Board, a possible requirement to invest further capital to increase the height of the chimney and build oil tank farm dykes, and the declining steam demand due to the competitive attraction of natural gas makes continued operation of the steam plant a financial burden rather than an asset for the Alliance Building Corporation.

Under these circumstances, Alliance do not contemplate renewing their contract with the Town of Ajax in 1980. In fact, if it were not for an estimated close-down cost of $1,250,000, they would probably give the 24-month notice required under the contract and shut the steam plant down as soon as possible. The shut-down cost includes provision for demolishing the steam plant, for the proceeds from sale of the released land, and for converting Alliance's buildings to other heat sources.

Once notice of plant shut down is given to the Town, the operating staff would naturally seek other employment. This could result in insufficient operators being available to meet the requirements of the Ontario Department of Labour in the final year of operation. Part of the anticipated close down cost is an allowance for staff bonuses to induce them to remain until the notice terminates, though this may not be allowed by the Federal Anti-Inflation Board. These close-down problems will still have to be faced in 1980 though wage controls may have been removed by then.

The shut down of the steam plant will affect not only the steam users but also the Town of Ajax and, indirectly, those provincial authorities having responsibility for energy conservation, air pollution control and industrial development.

## 10.1 - Steam Users

The greatest impact of steam plant shut down will fall on the private steam customers who will be forced to find an alternate heat source. The most attractive alternate for the large steam user probably will be the individual gas-fired boiler similar to those which have already been installed by two of the largest process steam users, Sandra Coffee and Ajax Textile. They have found this the most economic course of action due to the relatively low price being asked for natural gas at the present time.

This will not necessarily be the case for the smaller steam user. Taking Cametoid as an example, they purchase about 5,400,000 pounds of steam per year. To replace this

steam supply with a coil tube, gas-fired boiler, they would need to install a unit capable of generating 4,000 pounds of steam per hour. Though a unit of this size would be too small to require a full-time operator attendance under the present provincial regulations, a minimum of owner attendance and maintenance would be necessary.

Under present regulations and with current coil tube boiler design, full time operators would be required for a boiler plant operating at pressures above 15 psig and having a total installed capacity in excess of about 60,000 pounds per hour. For space heating, the steam pressure could be below 15 psig whereupon no operators would be required for a boiler plant having a total installed capacity not exceeding about 150,000 pounds of steam per hour.

In the public sector, the Town of Ajax and the Durham Region will also be considerably affected. The Town facilities, the schools and the hospital consumed over 10 per cent of the steam sold in 1975. The conversion to gas will save some $110,000 in fuel costs but only at the expense of between $500,000 and $600,000 in capital outlays by the municipalities.

The change in the source of heat would save Cametoid about $14,500 a year. However, this would be achieved only by investing in the order of $60,000 to install a new gas-fired boiler which would require four years of operation to pay for it. In comparison, Sandra Coffee, originally the largest steam consumer, spent about $170,000 on new boiler plant and have probably reduced their purchased heat cost by some $80,000 in 1976. At this rate their investment should be paid for in just over two years. However, it is understood that the price they paid was lower than prevailed at the time the conversion was carried out, a figure of $250,000 would probably be more appropriate for others with the same steam demand who are intending to convert.

A single boiler installation would not provide the degree of security available from a steam supply served by several boilers. If the steam supply security required by Cametoid should necessitate the installation of two boilers, the cost of installation would be increased by 50 per cent.

In the case of space heating loads, the type of heat generator will depend on the method existing for the distribution of heat within the individual building. In some cases gas-fired unit heaters would be adequate, especially in warehouses or light production areas. Where hot water or steam is circulated through the buildings, a gas-fired boiler would be the only answer. For forced air circulation, a gas-fired furnace similar to those used in private residences could be used.

The trade-off between heat cost savings and money invested in new heating plant will vary considerably. Notwithstanding, it is estimated that, together, the 50 private customers still buying steam from the Ajax steam system together will be required to spend something in excess of $2,000,000 on new boiler heating plants if the steam supply system is shut down. Included in this figure is $6 - 700,000 which will be spent by Alliance in converting its own properties which use steam. This sum is included in their shut down cost.

## 10.2 - Town of Ajax

Apart from the impact on the Town as a user of steam, there are the effects on the prospects for attracting new industries and creating new employment to be considered. In this respect, close down of the steam plant would mean immediate loss of jobs by 14 employees who operate the boilers.

As originally devised, the central steam plant installed with initial area development in the 1940's was intended to increase the attraction of the development for prospective tenants. In view of the cost of installing expensive coal burning boiler plants of their own, the steam supply no doubt played an important role in persuading companies to locate in Ajax and thus contribute considerably to the local economy. Oil at that time was restricted as an important strategic commodity and cheap natural gas was still a thing of the future in Ontario.

As oil and then natural gas become freely available, the cost of individual boiler plants decreased. By burning either fuel, the problems of ash and coal handling were avoided. The Ajax steam plant was converted from coal to oil firing for this reason. Natural gas was by far the cheaper fuel and in the sixties, a case could probably have been made for converting some of the process steam users from steam to gas heating.

The need to invest in new heating plant and the security of steam supply probably was the reason why those companies already connected to the steam plant did not take advantage of the low priced gas. However, some of the new companies locating in Ajax during the 1960's and early 1970's did not approach Alliance for a steam supply, choosing to use gas for their heating requirements. From this, it could be concluded that the availability of a central steam supply was not a factor in their choice of location.

Since 1970, rising fuel prices has forced the selling price of steam up to a point where long established

customers have found it economically advantageous to switch from steam to natural gas even though it has meant investment in new heating plants. Under these circumstances, the central heating steam supply will have no bearing on the selection of Ajax as a location for new industries. An exception could be a process operation requiring small amounts of steam annually but in short bursts at a high rate. In this case the annual steam cost would be low compared with the cost of a large capacity boiler. Such cases are probably the extreme exception and not a viable basis for speculation.

Under present circumstances, therefore, shut down of the steam plant will have little or no adverse effects on the promotion of Ajax as a site for new industry.

## 10.3 - Energy Conservation

The steam plant would be replaced by a large number of individual heating units located throughout the present steam supply area. Each of the 51 customers would not necessarily install his own unit. There could be cases, especially where common use is made of one building or of two or three closely adjacent buildings, where joint use could be made of a single heating unit. However, in general, the central steam plant operating with an average overall fuel utilization efficiency of about 50 per cent would be replaced by individual heating units operating at an average annual efficiency of about 70 per cent. In terms of heat value based on 1976 operating conditions, the annual heat consumption would be reduced by approximately 183 billion Btu or the equivalent of 29,000 barrels of oil.

Thus, in terms of heat value alone, shut down of the steam plant would be an improvement. However, this improvement is gained at the expense of a new annual requirement in Ontario for 430 million cubic feet of natural gas to replace 97,000 barrels of oil. Though the supply of this gas is being encouraged by the gas utilities at this moment, it is not necessarily compatible with long term predictions on the availability of gas nor the implied policies of government, both federal and provincial.

## 10.4 - The Environment

Subject to changes being made to the chimney height, the steam plant could operate in accordance with the requirements of the Ontario Ministry of the Environment with respect to impingement levels of sulphur dioxide and particulates.

If the steam plant is replaced by individual gas fired heaters, the problem of sulphur would essentially be eliminated. There would be, however, an increase in the amount of nitrous oxides discharged at low level, compared with the steam plant chimney, and the levels of these oxides at ground level could be increased significantly under the appropriate atmospheric conditions.

Quantitatively, based on 1976 steam consumptions, shut down of the oil-fired steam system would mean that 380 tons of sulphur would no longer be discharged from the Ajax steam plant to the atmosphere.

## 10.5 - Provincial Trade and Commerce

In this respect, efforts to attract new industries to the province would be virtually unaffected, essentially for the same reason that Ajax would be unaffected as discussed in Section 10.2. Perhaps the only way that provincial industrial promotion could be affected is at the instance of the Ministries of Energy and the Environment with their respective concerns for increased dependence on natural gas in the province and the adverse impact on the environment. Such promotion obviously would be hampered by the existing divergence in steam and gas heat costs.

In summary, therefore, on the positive side, there would be a reduction in the net consumption of energy in the form of fuel heat value and, compared with present conditions, the attraction of Ajax as a site for new industry and commerce will remain essentially unaffected.

The adverse effects of steam plant shut down would fall predominantly on the shoulders of steam customers who would have to find capital for new heating plant. The impact of the resulting increase in natural gas consumption in Ontario will have to be assessed by the Provincial Government in light of its energy policies.

# 11 - CONCLUSIONS AND RECOMMENDATIONS

It has been difficult to assimilate and evaluate the data necessary to form firm conclusions and recommendations regarding the continued operations of the Ajax steam plant. Future availability of fuel supplies by type and the price levels expected for those fuels are popular topics of conjecture. There is no uniformity in the Federal and Provincial Government energy policies by which decision-makers might be guided. Lastly, there is considerable variability in the forecast economic scenarios which will affect population and industrial growth in Ajax.

Accordingly, the recommendations in this report seek to minimize the exposure to the risks inherent when the information on which those proposals are based is of undefinable quality. However, it is considered that the conclusions and recommendations included in this report provide a basis for definitive action.

## 11.1 - Conclusions

The conclusions drawn from the study of the viability of the Ajax steam plant are as follows:

11.1.1 - The Ajax steam plant and distribution system, though well maintained and capable of continued satisfactory operation for at least 20 more years, are both inherently inefficient. This is due to their design, made 30 years ago under vastly different economic criteria to those prevailing today, compounded by the characteristics of the steam load and the low steam demand density.

The net average efficiency of fuel utilization is such that only about one half of the fuel heat energy fired in the steam plant boilers reaches the steam users.

11.1.2 - The rapidly increasing cost of fuel in recent years has meant that it now constitutes 68 per cent of the cost of operating the steam system. Because of the low fuel conversion efficiency, the steam selling price has been escalated to a point where it is no longer competitive with natural gas as is demonstrated by the number of steam customers who are converting or

considering converting to gas heating and thus reduce the annual amount of steam sold by Alliance.

11.1.3 - Under the current policies of the Ontario Energy Board, the rate of return on investment available from the steam plant is not acceptable to Alliance. This situation is being worsened by the diminishing steam load and it is evident that Alliance do not intend to continue operation of the steam plant beyond the expiry of their contract with the Town of Ajax.

11.1.4 - The efficiency of the steam plant could be increased by adding combustion air preheaters and operating at low excess air. However, the resulting fuel savings would not compensate for the annual cost of repaying the capital required to achieve them and certainly would not alter the competitive position of the steam compared with natural gas.

11.1.5 - Purchase and operation of the steam plant on a permanent basis by a public entity such as the Town of Ajax may bring some tax advantages and a need for lower rate of return. However, even with the maximum advantages from both areas, the resulting effect on the steam selling price probably would still not be sufficient to reverse the defection to gas.

11.1.6 - Refuse as an alternate fuel for steam generation by a privately owned and operated company would not be economically viable and thus provide effective competition for natural gas.

There may, however, be economic justification for an incinerator owned and operated as a public utility, with operation of the existing steam plant maintained meanwhile at present loads by some form of subsidy to be repaid later from operation of the incinerator plant. However, since such a subsidy would entail considerable government support, this matter should be resolved before any commitment is made to further study the incinerator proposal.

11.1.7 - On the assumption that the refuse heat recovery is not going to be proven feasible, there are no economic or technical grounds for continued operation of the Ajax steam supply system under the current fuel supply conditions. In this event, shut down of the steam plant by 1981, if not earlier, would seem inevitable.

This situation would exist for any other steam plant in Ontario operating under the same constraints and with the same competition from natural gas.

11.1.8 - (a) The impact on shut down will fall most heavily on the present steam customers who, though there would be an immediate reduction in annual heat cost, would be faced with finding varying amounts of capital to install their own gas boilers. The total investment required from the private steam users to convert to gas would be in excess of $2,000,000 and approaching $600,000 for the public consumers.

(b) As far as energy conservation is concerned, an annual consumption of 97,000 barrels of oil by the steam plant would be replaced by the consumption of 430 million cubic feet of natural gas by the steam users. Due to the difference in the efficiencies of operation on the two fuels, there would be a net heat energy saving of 183 billion Btu per year.

(c) Environmentally, sulphur discharged with flue gases from the steam plant would be reduced by about 380 tons per year.

(d) Demise of the steam supply system can be expected to have little adverse effect on the promotion of Ajax as an industrial/commercial development, both by the Town of Ajax and by the Provincial Government, at least in the foreseeable future.

11.1.9 - The general conclusion is that, apart from any government action to subsidize the operation of a refuse heat recovery plant in pursuit of their energy, environment or

trade development policies, the only potentially viable course of action is for Alliance to close the steam plant down in accordance with present plans.

## 11.2 - Recommendations

The recommendations based on the foregoing conclusions are that:

11.2.1 - Events be allowed to take their present course with the almost certain shut down of the steam plant by Alliance by 1981 and the consequent installation of new gas fired heating plant by the remaining steam users.

11.2.2 - This course of action be changed only if some way is found to subsidize at least the building and short term operation of a refuse heat recovery plant. In this event consideration should be given to steps to ensure the continued operation of the steam supply system on the most economic terms, as discussed in Section 7.5, at least until the various levels of government have had time to assess the results of this study and develop their policies on possible subsidy either of the steam plant operation or of the affected steam consumers in the event of steam plant shut down.

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# APPENDIX 1

## TABLE OF CONTENTS

# APPENDIX 1

# STEAM PLANT PERFORMANCE

## 1 - Steam Plant Heat Balance Caculations

The single line heat balance diagram of the steam plant based on a boiler output of 150,000 pounds of steam per hour is given by Figure A1.1.

### 1.1 - Assumptions

| | |
|---|---|
| Make up water temperature | 39$^{O}$F |
| Blowdown discharge temperature | 60$^{O}$F |
| Boiler efficiency (Average of actual ISL measured figures) | 78 percent |
| Blowdown | 2 percent |

### 1.2 - Steam and Water Conditions

| | | | |
|---|---|---|---|
| Boiler steam | 150 psig | 458$^{O}$F | 1251 h |
| Saturated water, boiler drum | 150 psig | 366$^{O}$F | 338.6 h |
| Deaerator, saturated steam | 5 psig | 228$^{O}$F | 1156 h |
| Deaerator, saturated water | 5 psig | 228$^{O}$F | 196 h |

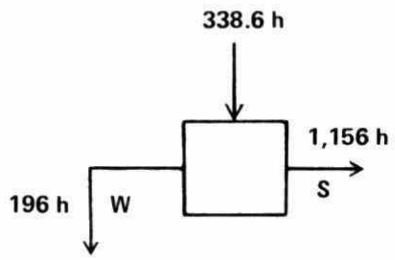
### 1.3 - Blowdown Flash Vessel Calculation

W = water S = steam

$$\text{Feed flow with 2\% blowdown} = \frac{150{,}000 \text{ lb/hr}}{0.98}$$

$$= 153{,}061 \text{ lb/hr}$$

$$\text{Blowdown from boiler} = 3{,}061 \text{ lb/hr}$$




Blowdown
Flash Vessel

W x 196 + S x 1156 = (W + S)338.6

Let S = 1

then W(338.6 - 196) = 1156 - 338.6

whence W = 5.75

S = 1

For 1 lb of blowdown W = .85 lb

S = .15 lb.

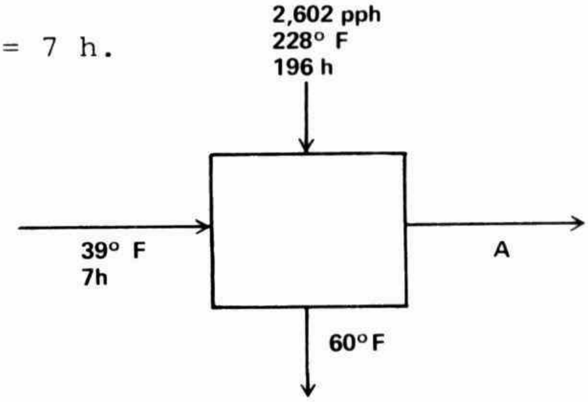
Blowdown to waste = .85 x 3061 = 2602 lb/hr

Blowdown flashed to deaerator = 459 lb/hr.

1.4 Blowdown Heat Exchanger Calculation

Assume blowdown is cooled to 60°F

Heat in make-up/lb at 39°F = 7 h.




Blowdown Heat
Exchanger

Heat recovered = 2,602(228 - 60)

= 437,136 BTU/hr.

Temperature rise = $\frac{437,136}{A}$ Assume = 3°F

Make-up to deaerator = 7 + 3 = 10°F

## 1.5 - Deaerator Calculation

### 1.5.1 - No Auxiliary Turbine in Use

$$A \times 10 + 459 \times 1156 + B \times 1251$$

$$= 153{,}061 \times 196$$

$$A + 125.1B + 53{,}061 = 2{,}999{,}996$$

$$\text{and } A + B + 459 = 153{,}061$$

$$124.1B + 52{,}602 = 2{,}846{,}935$$

$$B = 22{,}517 \text{ lb/hr.}$$

$$A = 2{,}999{,}996 - 53{,}061 - 125.1 \times 22{,}517$$

$$= 130{,}058 \text{ lb/hr.}$$

Check $A + B + D = C$

$$130{,}058 + 22{,}517 + 459 = 153{,}034$$

$$\text{Error} = 27$$

$$= .018\%$$

Blowdown heat exchanger effluent temperature check

$$\frac{437{,}136}{130{,}058} = 3.36^{\circ}F$$

### 1.5.2 - With Auxiliary Turbines in Use

Equipment for 225,000 lb/hr facility

| | |
|---|---|
| Boiler feed pump | 630 hp |
| Fans | 265 hp |
| | 895 say 900 hp. |

For Ajax at 150,000 lb/hr and 50% fan use

$$hp = \left(630 + \frac{265}{2}\right)\frac{150}{225} = 508$$

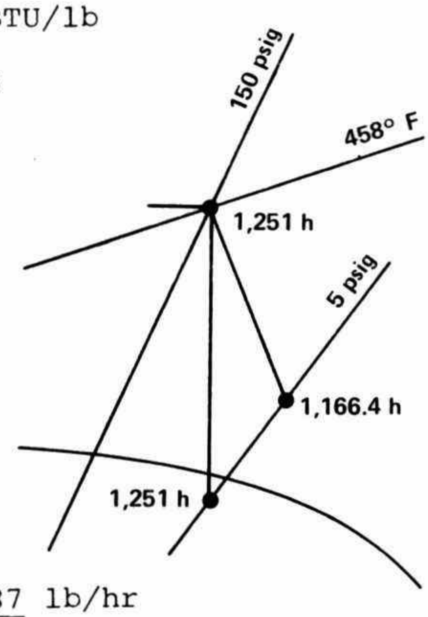
$$= 1{,}293{,}887 \text{ BTU/hr.}$$

Assumed turbine internal efficiency 60 percent.

Adiabatic heat drop 141 BTU/lb

Actual heat drop 141 x .6

= 84.6 BTU/lb




Steam required = $\frac{1,293,887}{84.6}$ lb/hr

= 15,294 lb/hr.

Heat to deaerator from main steam header without turbines:

= 22,517 x 1251 = 28,168,767 BTU/hr

with turbine:

= 28,168,767 - 15,294 x 1166.4

= 10,329,846 BTU/hr.

Steam flow to deaerator through PRV

= $\frac{10,329,846}{1251}$ = 8,257 lb/hr

Total steam to deaerator

= 15,294 + 8,257 = 23,551 lb/hr.

1.6 - Steam Demand of Miscellaneous Auxiliaries

1.6.1 - Fuel Oil Heating

Fuel quantity = $\frac{150,000 \times 1055}{0.78 \times 18,000}$ lb/hr

= 11,271 lb/hr.

Heat to oil = 11,271 x 120 x .5 BTU/hr.

Steam required $= \frac{11,271 \times 120 \times .5}{970}$

= 697 lb/hr.

1.6.2 - Building Heating

Estimated at 500 lb/hr.

1.6.3 - Steam for Atomising

0.5 percent of boiler output

= .005 x 150,000 = 750 lb/hr.

1.6.4 - Total Steam for Auxiliaries

697 + 500 + 750 = 1,947 lb/hr.

1.7 - Steam Sent Out

1.7.1 - Without Miscellaneous Auxiliaries

= 150,000 - 23,551

= 126,449 lb/hr.

Ratio $\frac{\text{Steam sent out}}{\text{Steam generated}} = \frac{126,449}{150,000} \times 100\%$

= 84.3 %

Steam used in boiler house = 15.7%

1.7.2 - With Miscellaneous Auxiliaries

= 150,000 - 23,551 - 1,947

= 124,502 lb/hr.

Ratio $\frac{\text{Steam sent out}}{\text{Steam generated}} = \frac{124{,}502}{150{,}000} \times 100\%$

$= 83\%$

Steam used in boiler house $= 17\%$

## 2 - Distribution System Heat Loss Calculations

Theoretical heat losses from underground distribution mains.

### 2.1 - Assumptions

Temperature at pipe wall - Average of As Generated and saturated steam temperatures at 150 psig

$$= \frac{365 + 458}{2} = 410^{\circ}F$$

Average ground temperature -40°F

Insulation    1½ inch Thermobestos type Insulation is dry

Soil conductivity    15 BTU/hr/ft$^2$/°F

### 2.2 - Heat Loss per Foot Run of Main for Piping with 2 inch Insulation*

| Pipe Diameter Inches | Heat Loss BTU/lineal foot/hr |
|---|---|
| 1 | 90 |
| 2 | 97 |
| 3 | 104 |
| 4 | 115 |
| 6 | 137 |
| 8 | 160 |
| 10 | 190 |
| 12 | 220 |

* Canadian Johns Manville Thermal Tables for Underground Heating Mains at 400°F with 2 inch Thermobestos.

## 2.3 - Piping Lengths (ft)

| Pipe Section | Pipe Size Inches | 1 | 2 | 3 | 4 | 6 | 8 | 10 | 12 |
|---|---|---|---|---|---|---|---|---|---|
| A - B | | - | 1100 | - | - | 800 | 1700 | | |
| B - C | | 800 | | | | | | | |
| B - D | | | | | | | | 1800 | |
| D - E | | | | | | | | 1400 | |
| E - F | | | | | | 500 | 2400 | | |
| F - G | | | 200 | | | | 1400 | | |
| E - H | | 100 | | | 1600 | 1400 | 1200 | | |
| H - I | | | 600 | 600 | 300 | 1400 | 500 | | |
| I - J | | | | | 800 | | 1600 | | |
| D - K | | | 500 | | 1000 | 200 | | | 1200 |
| K - L | | 100 | 200 | 400 | 1800 | 600 | 400 | | |
| L - M | | | | | 1200 | | | | |
| M - N | | | | | 1600 | 2000 | | | |
| | Total | 1000 | 2600 | 1000 | 8300 | 6900 | 9200 | 3200 | 1200 |

## 2.4 - Theoretical Heat Loss From Pipe (2 inch Insulation)

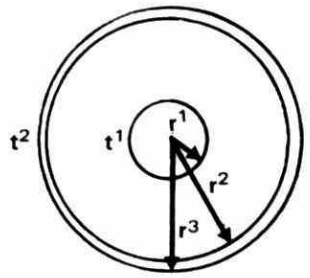
Excludes any additional losses due to increased heat transfer surface in chambers.

| Pipe Size Inches | Pipe Length ft | Unit Loss Rate BTU/ft/hr | Total Loss BTU/ hr x $10^3$ |
|---|---|---|---|
| 1 | 1000 | 90 | 90 |
| 2 | 2600 | 97 | 252 |
| 3 | 1000 | 104 | 104 |
| 4 | 8300 | 115 | 955 |
| 6 | 6900 | 137 | 945 |
| 8 | 9200 | 160 | 1472 |
| 10 | 3200 | 190 | 608 |
| 12 | 1200 | 220 | 264 |
| | | Total for System | 4690 |

## 2.5 - Check Calculation for 1½ inch Insulation

Heat loss/ft$^2$/hr.

$$\frac{t_1 - t_2}{\dfrac{r_1 \log_e \frac{r_2}{r_1}}{K_1} + \dfrac{r_1 \log_e \frac{r_3}{r_2}}{K_2} + \dfrac{r_1}{r_3} Re}$$




$K_1$ Insulation

$K_2$ Containing Structure

Re Resistance of Soil

8 inch Pipe

$$\frac{400 - 40}{\dfrac{4 \log_e 5\frac{1}{2}}{K_1} + \dfrac{4 \log_e \frac{5\,3/4}{4}}{K_2} + \dfrac{4}{5\,3/4} Re}$$

$$= \frac{360}{\dfrac{4 \log_e 1.375}{K_1} + \dfrac{4 \log_e 1.4375+}{K_2} + .695Re}$$

$$= \frac{360}{\dfrac{4 \times .32}{K_1} \quad \dfrac{4 \times .36}{K_2} + .695Re}$$

$$= \frac{360}{\dfrac{1.28}{K_1} + \dfrac{1.44}{K_2} + .695Re} \text{ BTU/ft}^2\text{/hr.}$$

$K = 10$ BTU/ft$^2$/in/$^o$F

$K_1 = .5$ BTU/ft$^2$/in/$^o$F

$K_2 = 312$

$Re = \dfrac{1}{K} = .1$

$$= \frac{360}{2.6 + 0 + .07} = \frac{360}{2.7}$$

$= 133$ BTU/ft$^2$ of pipe

Area of Pipe/ft run $\simeq$ 2 ft$^2$

Heat loss = 266 BTU/lin. ft

Approximate difference of losses $\frac{266}{160} = \frac{5}{3}$

This is basically what could be expected for a 1½ inch as opposed to a 2 inch thick system of insulation.

Total heat loss of Item 2.4 corrected for 1½ inch insulation

$$= 4{,}690 \times \frac{5}{3} \times 10^3 \text{ BTU/hr.}$$

$$= 7.816 \times 10^6 \text{ BTU/hr.}$$

Approximate equivalent steam quantity = 7,816 lb/hr.

2.6 - <u>Heat Losses of Distribution and Pipe Expansion Chambers</u>

Assume 30 Chambers, 6" Pipe average size, Pipe Temperature 400$^o$F, Air 70$^o$F.

<u>Loss/ft of Pipe</u> (Malloy - Thermal Insulation P. 468)

<u>Un-insulated Pipe</u>

Still Air 1976 BTU/lin. ft

Air at 200 fpm - 2500 BTU/lin. ft

With 0$^o$F Air Temperature, approximate loss would be

3100 BTU/lin. ft

Allowing 20 ft of 6 inch pipe per chamber, heat loss would be

Winter 30 x 20 x 3100 BTU/hr

$= 1860 \times 10^3 \simeq 1860$ lb/hr

Summer 30 x 20 x 2500

$= 15000 \times 10^5 \simeq 1500$ lb/hr

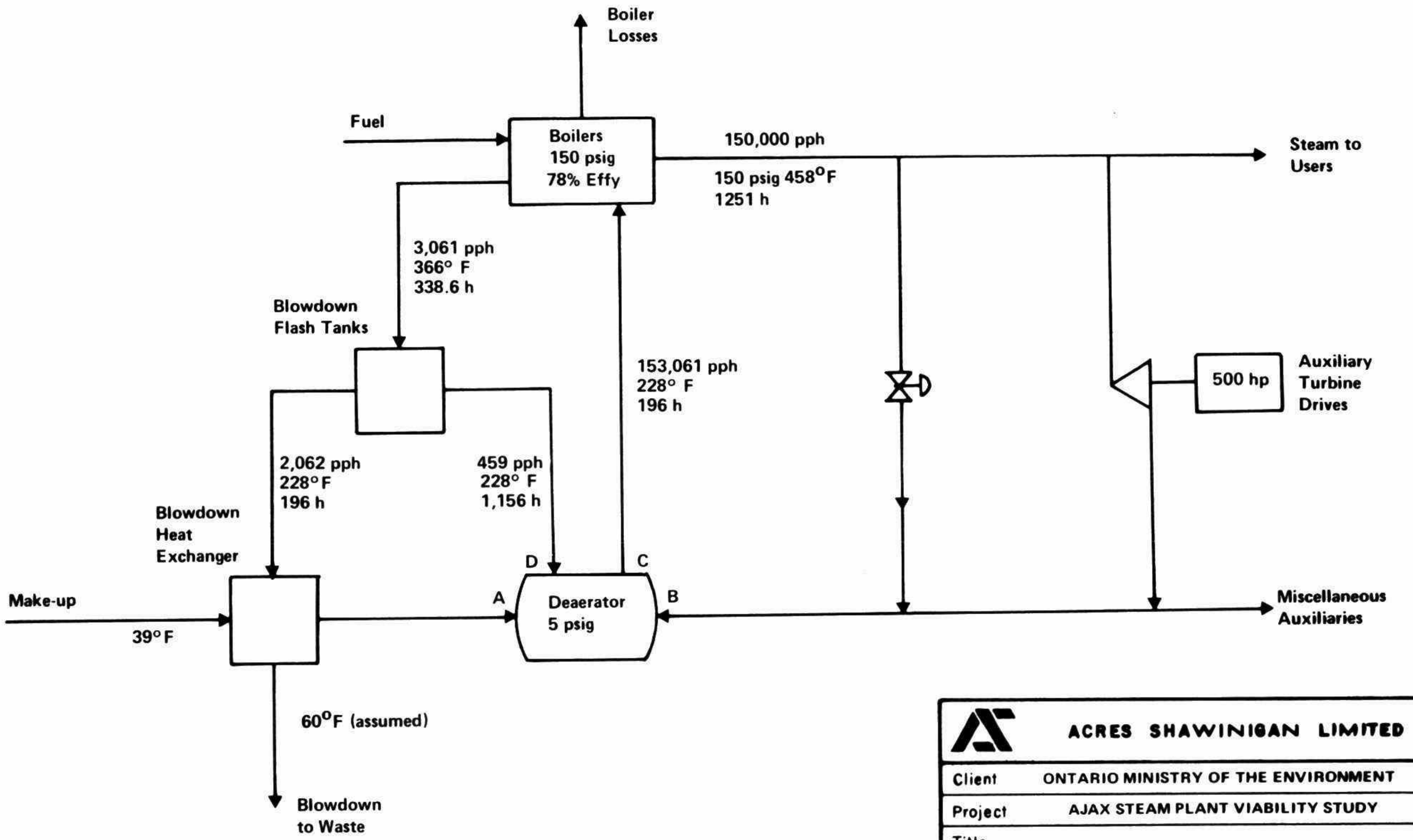
<u>Insulated Pipe</u>

Pipe insulation 2½ inch

Heat loss = 120 BTU/lin. ft

1.7 - Total Steam Loss

| | | | | |
|---|---|---|---|---|
| Winter | 7800 + 1860 | = | 9660 | lb/hr |
| Summer | 7800 + 1500 | = | 9300 | lb/hr |




ACRES SHAWINIGAN LIMITED

| | |
|---|---|
| Client | ONTARIO MINISTRY OF THE ENVIRONMENT |
| Project | AJAX STEAM PLANT VIABILITY STUDY |
| Title | HEAT BALANCE DIAGRAM |
| Date | DECEMBER 1976 · Fig. No. A1.1 |

# APPENDIX 2

## MODIFICATIONS TO STEAM PLANT

The following is a summary of the calculations undertaken to determine the effect on boiler efficiency of:

- installing air preheaters in the flue gas breeching
- modifying the fuel firing system to operate on low excess air.

### 1 - General

| | |
|---|---|
| Enthalpy of steam generated | 1251 BTU/lb |
| Enthalpy of boiler feed | 196 BTU/lb |
| Added heat | 1055 BTU/lb |
| Latent heat | 970.4 BTU/lb |

Average efficiency of the boilers (1975 figures)

| | |
|---|---|
| Fuel burnt | 3,712,984 gallons |
| Steam generated | 499,338,030 lb |
| Fuel used/1000 lb steam = | 7.436 gallons |

$$\text{Average efficiency} = \frac{1000 \times 1055 \times 100}{7.436 \times 180{,}000} \text{ percent}$$

$$= 78.8 \text{ percent.}$$

### 2 - Addition of Air Preheater

With the addition of air preheaters on the Ajax boilers the average efficiency gain is expected to be in the order of 4 percent.

New efficiency = 82.8 percent

Fuel reduction/100 lb of steam generated

$$= 7.436 \left(1 - \frac{78.8}{82.8}\right) \text{ gallons}$$

$$= 7.436 \times .048$$

= 0.357 gallons/1000 lb generated.

New fuel consumption = 7.079 gallons/1000 lb generated.

Ratio of steam generated to steam sold

$$= \frac{1}{.84} \times \frac{1}{.79} = 1.507.$$

Steam generated for 300 million pound sold per year

$$= 300 \times 10^6 \times 1.507 \text{ pounds} = 452.1 \times 10^6 \text{ pounds}$$

Fuel saved per year

= 161,400 gallons

Fuel cost saving

= 161,400 x 29¢

= $46,806.

3 - Effect of Using Low Excess Air

Estimated improvement in boiler efficiency is 1½ percent

Fuel reduction/1000 lb steam $= 7.079\left(1 - \frac{82.8}{84.3}\right)$ gallons

= .126 gallons

Fuel saved per year = $452.1 \times 10^6 \times .126$ gallons/1000

= 56,965 gallons

Fuel cost saving = 56,965 x 29¢ = $16,520

4 - Total Potential Cost Saving

Fuel cost reduction:

| | |
|---|---|
| Air heaters | $46,806 |
| Low excess air | 16,520 |
| | $63,326 say $63,000 |

Fuel savings per 1000 pounds of steam sold

$$= \frac{63,000}{300,000} = 21¢$$

## APPENDIX 3

## FINANCIAL MANAGEMENT - CALCULATION

INDUSTRIAL STEAM LIMITED

TABLE A3.1

Page 1

Income and Expenditure Accounts for
The Seven Years Ended December 31, 1977 (Note 1)

| | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | Notes | Adjusted 1975 | Projected 1976 | 1977 |
|---|---|---|---|---|---|---|---|---|---|---|
| Steam Sales and Revenues | $563,875 | $583,132 | $694,327 | $751,888 | $1,032,750 | $1,279,557 | 3 | $1,279,557 | $1,563,000 | $1,584,000 |
| Plant Operating Costs | | | | | | | | | | |
| Fuel | $253,322 | $298,365 | $343,684 | $399,967 | $ 584,136 | $ 925,150 | 4 | $ 925,150 | $ 964,000 | $ 915,000 |
| Plant Salaries | 127,798 | 135,936 | 147,043 | 166,611 | 175,935 | 212,504 | 5 | 212,504 | 237,000 | 262,000 |
| Depreciation | 74,168 | 76,565 | 79,198 | 79,153 | 79,067 | 154,581 | 6 | 78,887 | 78,000 | 78,000 |
| Municipal & Other Taxes | 20,038 | 20,057 | 21,695 | 22,281 | 30,831 | 34,531 | 7 | 31,416 | 34,000 | 37,000 |
| Repairs & Maintenance | 17,809 | 12,905 | 21,954 | 18,390 | 19,751 | 19,662 | 8 | 19,662 | 22,000 | 24,000 |
| Water | 10,749 | 11,455 | 13,090 | 11,815 | 12,839 | 19,229 | 9 | 19,229 | 20,000 | 21,000 |
| Water Treatment | 7,723 | 10,757 | 10,582 | 14,112 | 16,211 | 19,983 | 10 | 19,983 | 21,000 | 22,000 |
| Power & Light | 2,605 | 2,902 | 2,861 | 3,811 | 4,122 | 4,953 | 11 | 4,953 | 5,000 | 5,000 |
| Employee Benefits | 11,902 | 13,464 | 15,105 | 14,043 | 16,847 | 14,312 | 12 | 14,312 | 16,000 | 18,000 |
| | $526,114 | $582,406 | $655,212 | $730,183 | $ 939,739 | $1,404,905 | | $1,326,096 | $1,397,000 | $1,382,000 |
| Gross Profit (Loss) | $ 37,761 | $ 726 | $ 39,115 | $ 21,705 | $ 93,011 | $ (125,348) | | $ (46,539) | $ 166,000 | $ 202,000 |
| General & Administrative Expenses | | | | | | | | | | |
| Salaries | $ 20,148 | $ 15,872 | $ 15,631 | $ 15,927 | $ 14,900 | $ 12,210 | 13 | $ 12,210 | $ 13,000 | $ 14,000 |
| Automobile | 1,732 | 2,116 | 1,704 | 1,958 | 2,102 | 2,082 | | 2,082 | 2,000 | 2,000 |
| Insurance | 4,553 | 4,357 | 5,663 | 4,241 | 3,642 | 4,182 | | 4,182 | 4,000 | 4,000 |
| Professional Services | 4,405 | 2,017 | 1,379 | 5,374 | 13,010 | 9,901 | 14 | 15,000 | 15,000 | 15,000 |
| Office Expenses | 1,740 | 2,755 | 1,404 | 1,197 | 3,309 | 1,812 | | 1,812 | 2,000 | 2,000 |
| Telephone | 635 | 632 | 580 | 663 | 742 | 863 | | 863 | 1,000 | 1,000 |
| Bad Debts | 92 | -- | 17,942 | -- | 3,638 | 1,244 | | 1,244 | 1,000 | 1,000 |
| Interest | 10,653 | 6,448 | 843 | -- | 14,188 | 26,802 | 15 | 10,802 | -- | -- |
| | $ 43,958 | $ 34,197 | $ 45,146 | $ 29,360 | $ 55,531 | $ 59,096 | | $ 48,195 | $ 38,000 | $ 39,000 |
| Profit (Loss) From Operations | $ (6,197) | $(33,471) | $ (6,031) | $ (7,655) | $ 37,480 | $ (184,444) | 16 | $ (94,734) | $ 128,000 | $ 163,000 |
| Other Income | $ 915 | $ 1,142 | $ 8,634 | $ 10,541 | $ 10,426 | $ 8,873 | 17 | $ 8,873 | $ 9,000 | $ 9,000 |
| Share of Earnings from Tenancy in Common | -- | -- | -- | -- | -- | 602,455 | | -- | -- | -- |
| | $ 915 | $ 1,142 | $ 8,634 | $ 10,541 | $ 10,426 | $ 611,328 | | $ 8,873 | $ 9,000 | $ 9,000 |
| Earnings Before Income Taxes | $ (5,282) | $(32,329) | $ 2,603 | $ 2,886 | $ 47,906 | $ 426,884 | | $ (85,861) | $ 137,000 | $ 172,000 |
| Provision for Income Taxes (Note 2) | -- | -- | -- | -- | -- | 214,000 | | -- | 69,000 | 86,000 |
| Net Earnings for the Year | $ (5,282) | $(32,329) | $ 2,603 | $ 2,886 | $ 47,906 | $ 212,884 | 18 | $ (85,861) | $ 68,000 | $ 86,000 |
| Cash Flow (Deficit) from Operations | $ 67,971 | $ 43,094 | $ 73,167 | $ 71,498 | $ 116,547 | $ (29,863) | 19 | $ (15,847) | $ 141,000 | $ 159,000 |

INDUSTRIAL STEAM LIMITED

Notes to Income and Expenditure
Accounts for the Seven Years Ended
December 31, 1977

1. Figures for 1970 to 1975 extracted from audited statements. Figures for 1975 adjusted to conform with projections for 1976 and 1977.

2. For the years 1972 to 1974, income taxes otherwise payable, amounting to $24,800, have been reduced by claiming depreciation for tax purposes in excess of those for book purposes.

   In 1975, income taxes otherwise payable have been deferred by deducting certain carrying charges and mortgage reserves allowable for tax purposes.

3. Not applicable.

   The following assumptions have been made for the 1976 and 1977 projections:

   1976

   (a) Volume of sales will decrease by five per cent to 314 M lbs. from 330.6 M lbs. in 1975.

   (b) Forty-one per cent of sales (219 M lbs.) will be generated in the period January 1 to March 31 and 59 per cent (185 M lbs.) in the period April 1 to December 31, based on historic information.

   (c) The application for an 18 per cent increase will be effective April 1, 1975.

   (d) The average rate for the period January 1 to March 31 will be $4.50 per 1000 lbs. and that for the period April 1 to December 31 will be $5.31 (i.e., an increase of 18 per cent).

   (e) Any increase in fuel oil prices will be passed on to customers in accordance with the formula ".1 cent per gallon = 1.12 cents per 1000 lbs."

   1977

   (a) Volume of sales will decrease by five per cent to 298 M lbs. from 314 M lbs. in 1976.

(b) The average rate for the year will be $5.31 per 1000 lbs.

(c) As in (e) above.

4. Projected fuel usage for 1976 of 3,517,000 gallons at 27.4 cents per gallon, and for 1977, 3,338,000 gallons at the same price. (Assumed that any fuel price increases will be passed on to customers as indicated in 3(e) above.)

5. Increase in plant salaries of 12 per cent per annum in accordance with a union contract ending March 31, 1977. Increase at the rate of 10 per cent per annum assumed for the period April 1 to December 31, 1977.

6. Steam plant and equipment is being depreciated on a straight-line basis over its estimated useful life. The plant was re-valued in 1968 and a depreciation base established. Subsequent additions have been depreciated as follows:

| | |
|---|---|
| Steam lines | - over 33 years |
| Boilers | - over 30 years |
| Compressors, miscellaneous equipment and parts | - over 20 years |
| Meters | - over 15 years |

Automotive equipment is being depreciated on a reducing balance basis at 30 per cent per annum. (Depreciation for 1975 was $585, and that for 1976 will be $409, and for 1977, $26.)

7. Adjustment in 1975 for capital tax of $3,115 under-provided in 1974. A 10 per cent per annum increase in municipal taxes has been projected for 1976 and 1977.

8. Ten per cent per annum increase projected for 1976 and 1977.

9. Five per cent per annum increase projected for 1976 and 1977 (on the basis of a 10 per cent increase reduced by five per cent for anticipated reduction in output).

10. As in 9 (above).

11. As in 9 (above).

12. Projections based on 6.7 per cent of plant salaries as determined in 1975.

13. Ten per cent per annum increase projected for 1976 and 1977.

14. The 1975 figure in the draft statements is made up as follows:

| | |
|---|---|
| Legal - Re Energy Board and Sundry | $ 5,288 |
| 1975 Audit | 2,000 |
| Special Investigation by Accountants | 1,975 |
| Sundry | 638 |
| | $ 9,901 |

The adjusted figure for 1975 and the projections for 1976 and 1977 are made up as follows:

| | |
|---|---|
| Management fee ($1,000 p.m.) | $12,000 |
| Audit | 2,000 |
| Legal | 1,000 |
| | $15,000 |

The balance of the legal fees and the costs of the special investigation in 1975 are considered to be non recurrent, and have therefore been excluded from the above.

15. The 1975 figure in the draft statements is made up as follows:

| | | |
|---|---|---|
| Mortgage Interest Payable | $108,750 | |
| Miscellaneous Interest | 1,059 | $109,809 |
| Deduct | | |
| Interest on Amount Due from Affiliated Company | $ 34,291 | |
| Interest on Advanced to Tenancy in Common | 35,917 | |
| Interest on Loan Receivable from Goldfan Holdings Limited | 12,799 | 83,007 |
| | | $ 26,802 |

Whilst the mortgage is bearing interest at the rate of prime +4-1/2 per cent interest on the amount due from affiliated company and that on advances to tenancy in common is calculated at the rate of prime +2 per cent. The difference between these rates amounts to $16,000.

The adjusted interest for 1975 which relates to that part of the mortgage utilized to finance operations therefore amounts to $10,802 (i.e., $26,802 - 16,000).

It has been assumed that any cash flow generated in 1976 and 1977 will be used, firstly, to notionally repay the effective borrowing for operations (as set out above), and secondly, to finance future capital commitments, e.g., the new smoke stack and the dyking of the oil tanks (estimated cost of $250,000).

16. If the application for the increase in rates is not granted, the 1976 projected profit from operations of $128,000 will be converted into a loss of $21,850 (185 M X 81¢ - $128,000), and the 1977 profit of $163,000 into a loss of $78,380 (298 M X 81¢ - $163,000).

17. Sundry rental income.

18. Excludes share of earnings from tenancy in common which bears no relevance to steam operations.

19. If the application for the increase in rates is not granted, the 1976 projected cash flow from operations will be converted to a deficit of $8,850 and the 1977 cash flow into a deficit of $82,380.

# INDUSTRIAL STEAM LIMITED

## Pro Forma Balance Sheets at December 31, 1975, 1976 and 1977 (Note 1)

| | Notes | Adjusted 1975 | Projected 1976 | 1977 |
|---|---|---|---|---|
| Current Assets | | | | |
| Receivables | | $ 213,609 | $ 214,000 | $ 214,000 |
| Oil Inventory | | 13,152 | 13,000 | 13,000 |
| Deposit | | 2,449 | 2,000 | 2,000 |
| | | $ 229,210 | $ 229,000 | $ 229,000 |
| Fixed Assets | | | | |
| Steam Plant & Equipment | 2 | $1,120,573 | $1,167,000 | $1,331,000 |
| Automotive & Office Equipment | | 5,234 | 5,000 | 5,000 |
| | | $1,125,807 | $1,172,000 | $1,336,000 |
| Less Accumulated Depreciation | | 278,806 | 357,000 | 435,000 |
| | | $ 847,001 | $ 815,000 | $ 901,000 |
| Land | | 8,460 | 8,000 | 8,000 |
| | | $ 855,461 | $ 823,000 | $ 909,000 |
| | | $1,084,671 | $1,052,000 | $1,138,000 |
| Current Liabilities | | | | |
| Bank Indebtedness | | $ 6,335 | $ -- | $ -- |
| Payables | | 184,484 | 184,000 | 184,000 |
| Due to Parent Company | | 17,042 | -- | -- |
| | | $ 207,861 | $ 184,000 | $ 184,000 |
| Long-Term Liability | | | | |
| Mortgage Payable | 3 | 77,000 | -- | -- |
| | | $ 284,861 | $ 184,000 | $ 184,000 |
| Shareholders' Equity | | | | |
| Preference Shares | | $1,337,560 | $1,338,000 | $1,338,000 |
| Common Shares | | 2,000 | 2,000 | 2,000 |
| | | $1,339,560 | $1,340,000 | $1,340,000 |
| Deficit | | 539,750 | 472,000 | 386,000 |
| | | $ 799,810 | $ 868,000 | $ 954,000 |
| | | $1,084,671 | $1,052,000 | $1,138,000 |

# INDUSTRIAL STEAM LIMITED

## Notes to Pro-forma Balance Sheets at December 31, 1975, 1976 and 1977

1. 1975 based on adjustments per income and expenditure account.

   (a) To exclude non-recurrent items.

   (b) To exclude non-steam operations.

   1976 and 1977 projections exclude non-steam operations.

2. Cash available for additions (e.g., the new smoke stack, dyking of the oil tanks and other minor replacements) amounts to $46,000 in 1976 (plus $69,000 in respect of income taxes provided but not payable) and $161,000 in 1977.

3. Estimated portion of borrowings relating to steam operations repaid with cash generated in 1976.

# INDUSTRIAL STEAM LIMITED

## Total Cost of Service
## For the Year Ending December 31, 1976

Cost and Expenses - Per Applicant's Exhibit 7B (Schedule "C")

| | | |
|---|---|---|
| Fuel Cost | $ 964,000 | |
| Depreciation | 78,000 | |
| Municipal & Other Taxes | 34,000 | |
| Other Plant Operating Costs | 321,000 | |
| | $1,397,000 | |
| General & Administrative Expenses | 38,000 | |
| | $1,435,000 | |
| Deduct other Income | 9,000 | |
| Cost of Service Before Return Component | | $1,426,000 |
| Return Component (see Note) | | 100,000 |
| Total Cost of Service | | $1,526,000 |

Note: Return component is based on an assumption of a 10 per cent rate of return on an estimated rate base of $1,000,000.

## INDUSTRIAL STEAM LIMITED

### Calculation of Excess Revenue
### For the Year Ending December 31, 1976

| | |
|---|---|
| Revenues - Steam Sales (Note 1) | $1,563,000 |
| Add Annualization Adjustment (Note 2) | 104,490 |
| Total Annualized Revenues | $1,667,490 |
| Revenue Requirement Based on Total Cost of Service (Note 3) | 1,526,000 |
| Excess Revenues | $ 141,490 |
| Total Sales Volumes (Note 4) | 314,000,000 lbs. |
| Excess Revenues Per 1,000 lbs. | $0.45 |

Note

1. Per Exhibit 7B (Schedule "C").
2. Based on assumption that increase in rates from $4.50 to $5.31 viz $0.81 will be effective retroactively from January 1, 1976, on volume of 129 M lbs. (See Notes 3(b) and 3(d), Exhibit 7B.)
3. Per Schedule B.
4. Per Note 3(a) of Exhibit 7B (Schedule "C").

## INDUSTRIAL STEAM LIMITED

### Rate Base - Investment in Steam Operations
### December 31, 1976 (Projected)

| | | |
|---|---|---|
| **Fixed Assets** | | |
| Per Amendment 2 - Exhibit 7E | | \$823,000 |
| **Working Capital** | | |
| Oil Inventory | 13,000 | |
| Deposit | 2,000 | 15,000 |
| **Working Cash Allowance** | | |
| Fuel Cost - 7 days' allowance $964{,}000 \times \frac{7}{365} =$ | | 18,490 |
| Operating Expenses | 355,000 | |
| Administrative & General | 38,000 | |
| 45 days' allowance on | 393,000 | |
| $393{,}000 \times \frac{45}{365} =$ | | 48,450 |
| | | \$904,940 |

# INDUSTRIAL STEAM LIMITED

A. Rate Required to Earn
$100,000 in 1976

| | January 1 - April 30 $'000 | May 1 - December 31 $'000 | Total $'000 |
|---|---|---|---|
| Fuel Cost | 497* | 467 | 964 |
| Plant Salaries | 79 | 158 | 237 |
| Depreciation | 26 | 52 | 78 |
| Municipal & Other Taxes | 11 | 23 | 34 |
| Repairs & Maintenance | 11 | 11 | 22 |
| Water | 10 | 10 | 20 |
| Water Treatment | 10 | 11 | 21 |
| Power & Light | 3 | 2 | 5 |
| Employee Benefits | 5 | 11 | 16 |
| | 652 | 745 | 1,397 |
| General & Administrative Expenses | 13 | 25 | 38 |
| | 665 | 770 | 1,435 |
| Deduct Sundry Income | 3 | 6 | 9 |
| Cost of Service | 662 | 764 | 1,426 |
| Return Component | 74 | 26 | 100 |
| Total Cost of Service (Sales) | 736* | 790 | 1,526 |
| Projected Volume (Note 1) | 165 M* | 149 M | 314 M |
| Rate Required (Notes 1 & 2) | $4.46* | $5.30 | $4.86 |

*Actuals

Notes

1. Total projected sales volume - 314 M lbs.

   Therefore, 149 M lbs. (314 - 165) projected for the 2nd period. Average rate required to earn $26,000 ($100,000 - 74,000) = $5.30 per 1000 lbs.

2. At a rate of $4.86 per 1000 lbs. for the 2nd period, earnings for the 2nd period will be reduced by $66,000 to create a loss of $40,000. Earnings for the year will accordingly be reduced to $34,000.

# APPENDIX 4

## REFUSE INCINERATION

For the purposes of the report, a case was developed for the installation of incineration units at a location in the Ajax industrial and commercial section which, first, allowed ready access to the existing steam distribution system. Secondly, could supply steam to partially meet present demand and could be expanded as refuse availability increased. The characteristics of the plant and the assumptions built into the case are as follows:

### 1 - The Plant

(1) All costs are in 1976 dollars.

(2) The plant would initially have one incineration unit. The addition of further units would depend on future growth of the Ajax steam requirements. The unit features on-grate burning incineration to handle 250 tons per day of garbage with 100 per cent condensing capability and would be capable of operating at 50 per cent full load.

(3) Capital cost per incineration unit, exclusive of land and appropriation expenses which are estimated at one per cent of total plant capital cost, is $8,360,000. This does not include the cost of relocating the existing steam plant at the incinerator plant.

(4) Utilities, maintenance and supplies costs per unit would be $143,750 per year.

(5) Operation and maintenance personnel costs for a one-unit plant would be $378,000 per year (21 people at $18,000 per person). If future units are installed, four additional people would be required at an annual cost of $72,000 for each unit.

### 1.1 - Operating Assumptions

(1) The net steam recovery at the plant gate would be 3 lbs. steam per 1 lb. garbage input.

(2) Based on Figure 8.1, the plant capacity factor would be 0.67. It is assumed that over the next 10 years the steam demand would increase by 50 per cent. Two

incinerators could be operated at a capacity factor of 52 per cent.

(3) The steam distribution efficiency would be the 79 per cent prevailing in the existing system.

(4) To provide for scheduled and unscheduled maintenance time, a service factor of 23 per cent was assumed for the single unit and 15 per cent for the two-unit plant.

(5) The steam net generating capacity of incineration unit would be:

$$\frac{250 \text{ X } 2000 \text{ X } 3}{24} = 62{,}500 \text{ lb/hr}$$

(6) Saleable steam generated per year would be:

One-unit plant:

250 X 2000 X 3 X 365 X 0.67 X 0.79 X 0.75

= 217,000 X $10^3$ lb/year

Two-unit plant:

500 X 2000 X 3 X 365 X 0.52 X 0.79 X 0.85

= 383,000 X $10^3$ lb/year

(7) Ash residue yield = 0.15 tons/ton of garbage incinerated.

## 1.2 - Financial Assumptions

(1) The incineration plant building and equipment could be depreciated at an average six per cent per year declining balance.

(2) The plant is assumed to operate for 20 years from start-up date and all costs are expressed in current dollars. The plant would obviously operate beyond 20 years so no scrap value has been assigned, and calculated steam costs will be slightly on the high side.

(3) Land and appropriation costs are estimated at one per cent of plant capital cost and have been omitted from the analysis because of their relatively small impact.

(4) The credit from garbage dumping fees is calculated as follows (credit per ton = \$6.70):

One-unit plant:

250 X 365 X 0.67 X 0.75 X 6.70 = \$308,000/year

Two-unit plant:

500 X 365 X 0.52 X 6.70 X 0.85 = \$541,000/year

(5) Based on a \$6.70/ton dumping fee in a garbage land fill site, the cost of ash removal is calculated as follows:

One-unit plant:

250 X 365 X 0.67 X 0.15 X 0.75 X 6.70

= \$46,100/year

Two-unit plant:

500 X 365 X 0.52 X 0.15 X 6.70

= \$81,100/year

Shown as Table A4.1 is a pro forma Statement of Earnings assuming operation of both one- and two-unit plants. This table provides the input expenses data for a computer program to calculate the revenue needed from steam sales to cover expenses and provide various rates of return to the plant owner. It may be noted that:

(1) Municipal and other taxes are assumed roughly equal to the current situation for ISL.

(2) General and Administrative expenses are assumed roughly equivalent to ISL's current situation, with the exception that insurance on the plant reflects the higher capital value.

The results of the computer program testing the case for a single unit and a rate of return of 10 per cent are shown in Table A4.2. The average required revenue per thousand pounds of steam to provide associated rates of return from 0 to 20 per cent to the plant owner are summarized below:

| Rate of Return (per cent) | Required Revenue per MLB of Steam |
|---|---|
| 0 | \$ 4.30 |
| 5 | 6.49 |
| 10 | 9.08 |
| 15 | 12.26 |
| 20 | 15.57 |

## TABLE A4.1

## AJAX INCINERATION PLANT

### Pro Forma Statement of Earnings
### (Current Dollars)

| | One-Unit Plant | Two-Unit Plant |
|---|---|---|
| Revenues | | |
| Steam Sales | -- | -- |
| Garbage Handling Fees | 308,000 | 541,000 |
| | -- | -- |
| Expenses | | |
| Operation & Maintenance Personnel | 378,000 | 450,000 |
| Utilities, & Maintenance Supplies | 143,750 | 287,500 |
| Municipal and Other Taxes | 40,000 | 40,000 |
| Ash Disposal | 46,100 | 81,100 |
| Depreciation | -- | -- |
| | -- | -- |
| General and Administration | | |
| Salary | 28,000 | 28,000 |
| Automobile | 3,000 | 3,000 |
| Insurance | 50,000 | 100,000 |
| Office, Other Services | 20,000 | 20,000 |
| | 101,000 | 151,000 |
| Profit from Operation | -- | -- |
| Other Income | -- | -- |
| Earnings Before Income Taxes | -- | -- |
| Provision for Income Taxes | -- | -- |
| Net Earnings for the Year | -- | -- |

In the event the steam requirement in Ajax should increase by 50 per cent within 10 years and a second incinerator unit is installed at that time, the required steam selling price necessary to achieve a return of 10 per cent would be $9.99 per thousand pounds, as shown on Table A4.3.

The following comments apply to the results of the test:

(1) All expenses and revenues are current dollars, i.e., no escalation of labour, materials, taxes, insurance, etc., is reflected.

(2) The plant is assumed to operate as specified above and all available steam (allowing for service factors, distribution efficiencies, and the demand curve) is sold.

(3) The tax rate assumed above is 50 per cent.

INDEX TO CASH FLOW TABLE

(1) Total Revenue
(2) Operating and Maintenance Costs
(3) Net Revenue {(1) - (2)}
(4) Allowable Depreciation
(5) Taxable Income {(3) - (4)}
(6) Taxable Income Modified by Tax Loss Claims
(7) Income Tax Payable {(6) X Tax Rate}
(8) Net Revenue After Tax {(3) - (7)}
(9) Total Capital Expenditures
(10) Net Cash Flow on Total Capital {(8) - (9)}

Ajax Steam Plant--Run 7

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 0.0 | 501.6 | -501.6 | 0.0 | 0.0 | 0.0 | 8,360.0 | -8,360.0 |
| 1 | 1,970.5 | 400.9 | 1,569.6 | 471.5 | 1,098.1 | 596.5 | 298.2 | 1,271.3 | 0.0 | 1,271.3 |
| 2 | 1,970.5 | 400.9 | 1,569.6 | 443.2 | 1,126.4 | 1,126.4 | 563.2 | 1,006.4 | 0.0 | 1,006.4 |
| 3 | 1,970.5 | 400.9 | 1,569.6 | 416.6 | 1,153.0 | 1,153.0 | 576.5 | 993.1 | 0.0 | 993.1 |
| 4 | 1,970.5 | 400.9 | 1,569.6 | 391.6 | 1,178.0 | 1,178.0 | 589.0 | 980.6 | 0.0 | 980.6 |
| 5 | 1,970.5 | 400.9 | 1,569.6 | 368.1 | 1,201.5 | 1,201.5 | 600.7 | 968.9 | 0.0 | 968.9 |
| 6 | 1,970.5 | 400.9 | 1,569.6 | 346.0 | 1,223.5 | 1,223.5 | 611.8 | 957.8 | 0.0 | 957.8 |
| 7 | 1,970.5 | 400.9 | 1,569.6 | 325.3 | 1,244.3 | 1,244.3 | 622.2 | 947.4 | 0.0 | 947.4 |
| 8 | 1,970.5 | 400.9 | 1,569.6 | 305.8 | 1,263.8 | 1,263.8 | 631.9 | 937.7 | 0.0 | 937.7 |
| 9 | 1,970.5 | 400.9 | 1,569.6 | 287.4 | 1,282.2 | 1,282.2 | 641.1 | 928.5 | 0.0 | 928.5 |
| 10 | 1,970.5 | 400.9 | 1,569.6 | 270.2 | 1,299.4 | 1,299.4 | 649.7 | 919.9 | 0.0 | 919.9 |
| 11 | 1,970.5 | 400.9 | 1,569.6 | 254.0 | 1,315.6 | 1,315.6 | 657.8 | 911.8 | 0.0 | 911.8 |
| 12 | 1,970.5 | 400.9 | 1,569.6 | 238.7 | 1,330.9 | 1,330.9 | 665.4 | 904.1 | 0.0 | 904.1 |
| 13 | 1,970.5 | 400.9 | 1,569.6 | 224.4 | 1,345.2 | 1,345.2 | 672.6 | 897.0 | 0.0 | 897.0 |
| 14 | 1,970.5 | 400.9 | 1,569.6 | 210.9 | 1,358.6 | 1,358.6 | 679.3 | 890.3 | 0.0 | 890.3 |
| 15 | 1,970.5 | 400.9 | 1,569.6 | 198.3 | 1,371.3 | 1,371.3 | 685.6 | 883.9 | 0.0 | 883.9 |
| 16 | 1,970.5 | 400.9 | 1,569.6 | 186.4 | 1,383.2 | 1,383.2 | 691.6 | 878.0 | 0.0 | 878.0 |
| 17 | 1,970.5 | 400.9 | 1,569.6 | 175.2 | 1,394.4 | 1,394.4 | 697.2 | 872.4 | 0.0 | 872.4 |
| 18 | 1,970.5 | 400.9 | 1,569.6 | 164.7 | 1,404.9 | 1,404.9 | 702.4 | 867.1 | 0.0 | 867.1 |
| 19 | 1,970.5 | 400.9 | 1,569.6 | 154.8 | 1,414.8 | 1,414.8 | 707.4 | 862.2 | 0.0 | 862.2 |
| 20 | 1,970.5 | 400.9 | 1,569.6 | 145.5 | 1,424.1 | 1,424.1 | 712.0 | 857.5 | 0.0 | 857.7 |
| Total | 39,409.6 | 8,018.0 | 31,391.6 | 6,082.2 | 25,311.3 | 25,311.3 | 12,655.7 | 18,735.9 | 8,360.0 | 10,375.9 |

Per Unit Revenue = 9.080544; Rate of Return = 9.92407 per cent

Table A4.2

INDEX TO CASH FLOW TABLE

(1) Total Revenue
(2) Operating and Maintenance Costs
(3) Net Revenue {(1) - (2)}
(4) Allowable Depreciation
(5) Taxable Income {(3) - (4)}
(6) Taxable Income Modified by Tax Loss Claims
(7) Income Tax Payable {(6) X Tax Rate}
(8) Net Revenue After Tax {(3) - (7)}
(9) Total Capital Expenditures
(10) Net Cash Flow on Total Capital {(8) - (9)}

Ajax Steam Plant--Run 8

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0.0 | 0.0 | 0.0 | 501.6 | -501.6 | 0.0 | 0.0 | 0.0 | 8,360.0 | -8,360.0 |
| 1 | 2,168.7 | 400.9 | 1,767.8 | 471.5 | 1,296.3 | 794.7 | 397.3 | 1,370.4 | 0.0 | 1,370.4 |
| 2 | 2,168.7 | 400.9 | 1,767.8 | 443.2 | 1,324.6 | 1,324.6 | 662.3 | 1,105.5 | 0.0 | 1,105.5 |
| 3 | 2,168.7 | 400.9 | 1,767.8 | 416.6 | 1,351.2 | 1,351.2 | 675.6 | 1,092.2 | 0.0 | 1,092.2 |
| 4 | 2,168.7 | 400.9 | 1,767.8 | 391.6 | 1,376.2 | 1,376.2 | 688.1 | 1,079.7 | 0.0 | 1,079.7 |
| 5 | 2,168.7 | 400.9 | 1,767.8 | 368.1 | 1,399.7 | 1,399.7 | 699.8 | 1,068.0 | 0.0 | 1,068.0 |
| 6 | 2,168.7 | 400.9 | 1,767.8 | 346.0 | 1,421.7 | 1,421.7 | 710.9 | 1,056.9 | 0.0 | 1,056.9 |
| 7 | 2,168.7 | 400.9 | 1,767.8 | 325.3 | 1,442.5 | 1,442.5 | 721.3 | 1,046.5 | 0.0 | 1,046.5 |
| 8 | 2,168.7 | 400.9 | 1,767.8 | 305.8 | 1,462.0 | 1,462.0 | 731.0 | 1,036.8 | 0.0 | 1,036.8 |
| 9 | 2,168.7 | 400.9 | 1,767.8 | 287.4 | 1,480.4 | 1,480.4 | 740.2 | 1,027.6 | 0.0 | 1,027.6 |
| 10 | 2,168.7 | 400.9 | 1,767.8 | 771.8 | 996.0 | 996.0 | 498.0 | 1,269.8 | 8,360.0 | -7,090.2 |
| 11 | 3,827.7 | 468.6 | 3,359.1 | 725.5 | 2,633.6 | 2,633.6 | 1,316.8 | 2,042.3 | 0.0 | 2,042.3 |
| 12 | 3,827.7 | 468.6 | 3,359.1 | 681.9 | 2,677.1 | 2,677.1 | 1,338.6 | 2,020.5 | 0.0 | 2,020.5 |
| 13 | 3,827.7 | 468.6 | 3,359.1 | 641.0 | 2,718.1 | 2,718.1 | 1,359.0 | 2,000.0 | 0.0 | 2,000.0 |
| 14 | 3,827.7 | 468.6 | 3,359.1 | 602.6 | 2,756.5 | 2,756.5 | 1,378.3 | 1,980.8 | 0.0 | 1,980.8 |
| 15 | 3,827.7 | 468.6 | 3,359.1 | 566.4 | 2,792.7 | 2,792.7 | 1,396.3 | 1,962.7 | 0.0 | 1,962.7 |
| 16 | 3,827.7 | 468.6 | 3,359.1 | 532.4 | 2,826.7 | 2,826.7 | 1,413.3 | 1,945.7 | 0.0 | 1,945.7 |
| 17 | 3,827.7 | 468.6 | 3,359.1 | 500.5 | 2,858.6 | 2,858.6 | 1,429.3 | 1,929.8 | 0.0 | 1,929.8 |
| 18 | 3,827.7 | 468.6 | 3,359.1 | 470.4 | 2,888.6 | 2,888.6 | 1,444.3 | 1,914.8 | 0.0 | 1,914.8 |
| 19 | 3,827.7 | 468.6 | 3,359.1 | 442.2 | 2,916.9 | 2,918.9 | 1,458.4 | 1,900.6 | 0.0 | 1,900.6 |
| 20 | 3,827.7 | 468.6 | 3,359.1 | 415.7 | 2,943.4 | 2,943.4 | 1,471.7 | 1,887.4 | 0.0 | 1,887.4 |
| Total | 59,963.5 | 8,695.0 | 51,268.5 | 10,207.6 | 41,060.9 | 41,060.9 | 20,530.5 | 30,738.0 | 16,720.0 | 14,018.0 |

Per Unit Revenue = 9.993919; Rate of Return = 10.01855 per cent

Table A4.3